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RICHARD MOLDENKE, E. M., Ph. D.

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PAPERS.

VOL. IX. PART I.

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THE TRAINING OF FOUNDRY CHEMISTS.

By Dr. Edward Kirk, Philadelphia.

Permit me to present for your consideration a few thoughts upon foundry chemistry and proper training of foundry chemists.

At the present time there is not an institution of learning in this country that gives a practical course in foundry iron chemistry or foundry chemistry. While the employment of chemists in foundry practise has been strongly advocated for a number of years by the various foundrymen's associations and leading founders, they have failed to take any steps whatever to provide chemists educated for this work. And, at the present time, it is impossible to obtain from the graduating class from any of our colleges or schools a single chemist that is capable of doing anything as a foundry chemist, save making analysis of irons.

Not only are there no schools for the proper training of foundry chemists, but there are practically none for the teaching of foundry practise. While many other industries are taught at boys' mechanical training schools, at which boys are given a technical education in the line of the industry preparatory to learning a trade.

To prepare a student to become a chemist in foundry iron, he should be given a practical course in analysis of coke, coal, iron, and the mixing of irons from analysis that will enable him to produce from his analysis an iron at the cupola spout having any degree of hardness, softness and strength required in the various grades of work to be cast.

And he should be given a practical course in cupola management in every detail, from the chipping out of a cupola to dropping of the bottom. To prepare a student for a foundry chemist, as well as an iron chemist, he should be given a practical course in analysis of coal, coke, iron, fire brick, clay, loams, sands, facing, and all materials employed in foundries.

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When employed at a foundry, he should be competent to not only manage a cupola and produce irons suitable for the various grades of castings, but he should be competent to determine by analysis whether a sand is a good molding sand or not; if sands are suitable for heavy or light castings; if a facing or blacking will peel the sand from heavy or light work and give a smooth surface. And he should determine by analysis the suitability of all foundry material for the purpose to which it is to be employed in foundries, the suitability of which is now determined by trial of material—and loss in many cases from poor material.

With a chemist properly trained in analysis, mixing and melting of irons, foundry irons can, no doubt, be greatly improved. With a chemist properly trained as a foundry chemist, foundry practise, in my opinion, can be revolutionized and a much higher grade of castings produced at a less cost than at the present time.

To educate chemists for this work a thorough, practical course in foundry chemistry should be established as one of the courses of the curricula of all large technical schools. To prepare boys for learning the art of molding and better fit them for foremen and managers of foundries, a course in technical and practical foundry practise should be advocated at all the boys' mechanical training schools in this country.

These thoughts are respectfully submitted for your consideration, and should they meet with your approval, I would suggest that The American Foundrymen's Association, as a representative body, call the attention of the institutions of learning to the demand for practical chemists and founders, and urge them to take the necessary steps to supply the demand.

Under the present system of foundry chemistry, as advocated by some of our leading founders and practiced in some foundries, the chemist is only required to make analysis for the founder or foreman from which to make mixtures of iron, and the chemist is only responsible for the accuracy of his determination. That this system does not give satisfactory results is clearly indicated by the small number of foundries employing chemists and failure to improve the quality of foundry iron under this system.

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The chemist should not only be given charge of the laboratory, but should be given full charge of the cupola, the mixing and melting of irons, and be held responsible for the quality of iron at the spout. This is the practice in every foundry in which chemistry has been a real success.

At one of the largest and best known foundries in this country, at which a chemist has been employed for many years, the chemist has full charge of the laboratory, cupola and iron, and is not only responsible for iron at the spout, but has been under a written guarantee for years to produce iron at the spout having the density, hardness, softness, strength, etc., called for in specifications for government and other engineering work.

At this foundry, castings are made in the same heat weighing from a few ounces to many tons, for all of which a suitable iron must be provided. That a properly educated chemist can produce such irons at the spout has been clearly demonstrated at this works.

The silicon basis system in foundry irons has enabled the founder to produce castings with a little more certainty as to the degree of hardness and softness than by the fracture system. Beyond this it has been of no advantage to the founder, and to the foundry industry it has been a decided disadvantage, and if persisted in, will ruin the industry.

This may seem a broad assertion to those who have not investigated the matter, but those who have will, no doubt, fully agree with me.

That silicon reduces the strength of cast iron is a well known fact; and that the greater certainty in the degree of hardness and softness in castings is at the expense of the quality of iron is also a well-established fact.

Since the introduction of this system, it has been the aim of almost every furnaceman making foundry iron to increase the percent of silicon in his iron. And silicon has been increased to so great an extent that the quality of foundry iron has been greatly reduced; and the practical founder is no longer working for high silicon irons, but for an iron low in silicon or free from it, that his

casting may have strength and other desirable properties that are destroyed by silicon in cast iron.

What the founder wants to hold his own against steel is a foundry iron having all the characteristics of the hot and cold blast charcoal foundry irons of forty years ago. That such an iron cannot be produced by the silicon basis system is a well known fact to every practical iron chemist, and the sooner it is discarded and the true basis for the manufacture and mixing of foundry irons sought for, the better it will be for the foundry industry.

Many lines of castings, amounting to thousands of tons yearly, have been lost to steel. Many more will be lost if something is not done to improve the quality of foundry irons.

It is high time, gentlemen, that you rouse from your slumbers and gird on your armor in defense of your industry. If you do not, your foundry plants will be left to rot as have the rolling-mill plants of this country; for this is the age of steel, and only by an improvement of foundry iron can the founder hold his own against it.

TRAINING STUDENTS IN THE PRINCIPLES OF SCIENTIFIC AND COMMERCIAL FOUNDING.

By Thos. D. West, Sharpsville, Pa.

For some eight years or more attention has been called by writers to the desirability of colleges training students in the art of founding. A few colleges have fitted up departments for such training, and, in some instances, have adopted the writer's works to assist them in imparting instruction. Mention is made of this fact at the start merely to show that there is a want, and that some colleges are making an effort to fill it.

Recent discussion on this subject might lead to the conclusion that I am opposed to colleges giving instruction in founding. This is due to my objections to educating chemists to the assumption of entire responsibility for results in mixing and melting of iron for general founding, as recently advocated by Dr. Kirk,

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and others. Some may have attributed my objections on this point to prejudice, but any so doing are mistaken, for I can show the contrary by the fact that, for a year or more, I have had a work under way, designed especially for the use of colleges in training students in the principles of founding. The difference is, that I do not limit the chemist or any student to an understanding of the principles of cupola work only.

If the chemist is taken out of his laboratory to assume any responsibility for results of mixtures or melting, he should also be competent to assume responsibility for molding, as in the majority of foundries dividing responsibility of the mixing and melting from the molding can only cause contention, often with heavy losses, to all financially interested. Why this is so is best known to those having experience in the superintendency of general founding. It is also exemplified in nearly every instance in which the chemist has been led out by proprietors to take charge of mixing metals or the cupola work on account of assumed inability of foundry foreman, as can be read between the lines of chemists' writings, suggesting that the responsibility of the mixing and melting be placed in their hands.

It is not to be understood that I would place any obstacles in the way of the chemist learning all he can about the mixing of metals and cupola work, etc. On the contrary, I would have him extend his knowledge in these lines all that is possible, as this cannot but make him more profitable to his employers as a chemist. He can certainly be of assistance to the foundry foreman or superintendent who may be thought to require aid in attaining desired ends, just as the foundryman is often dependent upon the designer, pattern maker, machinist, or blacksmith, to enable him to achieve desired ends in making good castings.

Founders experienced in general work have been too tolerant in sitting idly by and allowing specialists and inexperienced founders to contend constantly for false theories and incorrect practices. The injury thus wrought is well evinced by a perusal of the transactions of some of our best engineering societies. Papers appear in them that, for impracticability, it is safe to say would

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be universally censured by any other profession. The great evil of such writings is in influencing those of narrow experience to believe the false theories and practices advanced to be correct, and to create a contention among writers very harmful to the progress of founding because of writers sticking to false theories and practices because they had in the beginning advocated them, and then did not know they were in error. The time has come to call a halt upon the forces retarding the advancement of true skill in founding, a calling, which, as the engineering world has lately come to discover, possesses extraordinary scope for the employment of the highest intelligence and far surpasses all other trades in demanding the best of the true mechanic.

While there has been this awakening lately to the scientific methods and the skill involved in successful founding, and many bright minds are striving to elevate the trade, its progress is hindered in one way by reason of specializing in the manufacture of castings. This most seriously limits the opportunity to obtain the full knowledge and experience formerly within the reach of nearly all who were engaged in the manufacture of castings, for the founders of the old days generally did a jobbing business.

The lack of the all around operations of the past, which afforded an opportunity to get a broad knowledge of the art of founding is apparent to broad experienced molders and founders in altogether too many articles appearing at the present day. A volume could be filled with different examples of evils resulting from the ill-conception of the knowledge, judgment and skill required in founding, and only obtainable by broad schooling in the art. The question is, how can steps be taken to remedy such evils and prevent matters from going from bad to worse? We can expect little assistance from the specialty shops for, even if they did make an effort to give the broadest education possible, it would be poor, at best. We must look in other directions.

What will seem strange to many is the inability of most of our present shops to give those who are coming along the knowledge that should be obtainable. Yet this is readily understood by experienced superintendents or foremen of heavy-work foundries,

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for in all such shops, the ordinary founder or molder, although he may work a lifetime, day in and day out, alongside the leading men, can never be brought to half realize what experience, skill, judgment, and caution are requisite in order to make a founder or molder one to be recognized as a leader in the art. It is chiefly to the principles of heavy founding that we must look for the education of any desiring a thorough knowledge of the art of founding; and the more varied the knowledge they have of the principles underlying work in green sand, dry sand and loam molding, the more thorough they will be, and the better fitted to assist in protecting and advancing the art of founding.

It will be noticed that an understanding of the principles involved in founding, and not the possession of experience, is cited above as aiding the founder to achieve desired results. Of course, if we can possess an understanding of principles, combined with experience, the better qualified we are for understanding and following the pursuits of the founder or molder. It will seem strange to those inexperienced in founding to be told that a founder or molder can be experienced in doing actual work and still lack knowledge of the principles involved in the art or the work they may have in hand; but it is the fact, and there are many examples. What successes such founders and molders had were greatly due to their imitating those gone before, whose knowledge had been obtained largely by sad and expensive experience. These, in many cases, could have been avoided had the founder or molder understood the principles involved in the work at hand. It is here that the value of foundry literature is displayed, as by its means one man's studies to discover principles can be transmitted to others and enable them to be benefited by their disclosures. . Foundry literature largely supplies the means of saving foundry practice from decay, due to specializing in the manufacture of castings. This tendency might, at length, cause all-around founding to be numbered with the lost arts, and bring great injury to its commercial interests, through uninformed competition. The worst evils of to-day are to be found in the ill-conception would-be

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founders entertain of the difficulties awaiting inexperienced men who enter the foundry business following the maxim, "Fools rush in where angels fear to tread."

We have several works on founding which any desiring to acquire the principles involved may study with profit. But that these works may do the greatest good, it is necessary to have opportunities whereby the principles of founding can be exhibited in actual workings. How best to do this is a question on which the writer has views to be expressed later on. Some may advise a novice or student to secure opportunities in one of the few general casting shops. This would work very well, providing instructors could be obtained that understood the principles of the work they were doing, and had the ingenuity to originate methods of teaching them; but, as explained above, founders and molders, as a rule, have depended more upon shop experiences than upon a study of the underlying principles in attaining what proficiency they possess. For the man who intends to earn his living by actual work on the floor or at the cupola, a certain amount of actual shop experience is necessary, and by being a good observer and following methods taught by skilled hands, he gets along without possessing much knowledge of principles. But for the man who aims to be a writer, proprietor, president, general manager, chemist or designer of foundry work, it is very essential that he, at least, understands the principles involved in scientific and commercial founding. If this cannot be obtained in the shops of general foundries, then I would suggest that colleges fit up so as to give opportunities for such instructions.

Why should not colleges equip their graduates in the science and art of founding as they do in machine shop or blacksmith work? Many graduates of the past wish they had had such a foundry training. There are very few presidents or general managers of iron works having foundries, but feel at home in the machine or blacksmith shop, and would like to do so in the foundry. But as to the latter, they are generally dependent entirely upon the judgment and management of subordinates, which arrangements, as a rule, give the head officials more worry, trouble and losses

than all else under their charge. There is no good reason why colleges could not give instructions in scientific and commercial founding that would be of great practical value to the graduate, whether he be a mechanical mining engineer or chemist.

What is required of colleges at the present day is that their course in founding be so laid out and systemized as to impress upon the student in a lasting way what is practical and meritorious in all that pertains to general founding. Then, when the graduate passes through a foundry in after-life, his equipment will be such as to give him a fair understanding if work is being properly done or when trouble arises, to assist in devising remedies. He should be able, also, to judge of what is meritorious in the writings of those laying claim to experimental knowledge of founding. The evils of the present methods of college instruction in founding are similar to those of the specialty shop, in that it affords but a smattering of what is true founding, and results in the same injury to the trade that is now found on every hand by reason of the general lack of a more thorough knowledge of broad founding.

In college instruction it is not necessary that castings of every character should be made, or, for that matter, castings of any great weight. What is wanted more is a course of instruction which will demonstrate good and bad results by different methods in the moulding of green sand, dry sand and loam work castings, with explanations for both conditions, to be followed by illustrations of the principles involved. Such work, if properly carried out, as it can be, would give an impetus to the advancement of the foundry art such as we have not known.

Establishing such a foundry school for the creation of competent managers would be a laudable work for anyone who could donate from $30,000 to $50,000, whether it be given to colleges or the American Foundrymen's Association, to be properly placed. Having such a donation to start with, an institution could be carried forward to be a great credit to the donor, to the trade and to all others interested in its success. An institution for the technical training of students in the principles of scientific and commercial founding would naturally create a strong rivalry between the tech-

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nical and practical men for high-paid positions. If practical men would strive more to understand the scientific basis of commercial founding as the students would do under the plan herein advocated and add a mastery of the science to their shop experience, they need never fear the technical man replacing them. If, on the other hand, they are going to remain asleep and not keep up with the progress of founding, as appears, for an example, in the slowness of many foremen and molders to study the making of mixtures by analysis and to labor to understand cupola work, the practical man will find it merely a question of "the survival of the fittest." It will be but a little time when they will have to take a back seat and become nonentities in the estimation of the mechanical world, never commanding any pay above the ordinary mechanic. The writer has seen this danger for some years, and, in preparing literature, has sought to put means in the hands of practical men whereby, with a little study, they could hold their supremacy. It is my hope that this paper may be the means of awakening many from the indifference they are at present exhibiting to the forces that are slowly relegating many of the so-called "practical" men to the rear.

It is for the best interest of the trade that every means be used to induce the practical man to become a capable manager of the mixing of metals by analyses and a master of cupola work, as well as of the floor. The foundry which is compelled to divide such responsibilities is lacking in internal harmony and economy of production as cited in the beginning of this paper. Such advancement for the practical man need not injure the technical man's chances of congenial and remunerative occupation, for there is room for him at the top as president, consulting or designing engineer or chemist. For in any of these positions, when thoroughly conversant with the principles of scientific founding, he cannot but be of greater value to his firm, and success will be more pronounced when he is seconded by the practical foundry superintendent or foreman, who always prefers to be under the supervision of a president or general manager possessing some practical knowledge of founding.

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THE DEVELOPMENT OF THE FOUNDRY BUSINESS.

By Prof. R. H. Richards, Mass. Inst. of Technology.

I have been asked to write my views upon this subject partly perhaps because I am much interested in the problem, and partly through my experience in developing a successful school of Metallurgy.

That men trained in scientific and commercial founding are needed is now generally acknowledged.

Business men and practical founders admit that advances are to be looked for along the lines of correct chemical mixing of the charge and of correct temperatures of melting and pouring.

The question comes up who is to direct this advance?

The practical foundryman, thoroughly trained in shop details, has become habituated to the guidance of arbitrary rules, and is, therefore, not well fitted to collect and arrange his facts and draw conclusions therefrom. On the other hand, this is exactly the quality the scientifically trained man possesses in a high degree. But while the latter has this quality there have been mistakes made in making use of him. It is a mistake to put a young chemist or even metallurgist into a laboratory and to call upon him to prescribe mixtures for castings, when he has never had any foundry experience, and when the question of the temperature of the metal at the time of melting or of pouring has never even presented itself to him. He does not possess the information needed to produce the desired result, and he is liable to make mistakes and bring discredit on himself and his training.

The solution of the difficulty will come by combining the scientific knowledge with the practical experience to the advantage of both.

Progress can only be made by experiment. The business man must be willing to spend a little money in experiments. The scientific worker, on the other hand, must be willing to assume a speed of progress that is sufficiently slow to guarantee against any serious mistakes.

In ocean navigation, compare the step which produced the Great Eastern with those that produced the Saxonia. The former was one long stride in advance and a great mistake, the latter

shows a series of small steps, and is a great success. Compare also the Ormsby iron furnace with the Duquesne furnaces. The former was a long step and a great failure, the latter have arrived at success by a great many small steps, each logically following the previous one.

How can the scientific and the practical training best be brought together? This seems to be the chief question at issue at the present time.

A young metallurgist, just graduated from a first-class scientific school, if he has average skill with his hands, should be put to work in the molding room of a foundry. This will teach him the principles of molding, of the use of patterns, of melting and of pouring, even if he does not stay at it long enough to become a skilled workman. Most important of all, it will gain him the respect of the foreman. He should then go to work in the chemical laboratory, noting the make-up of charges, analyzing the castings resulting therefrom, determining temperatures by calorimeter or pyrometer of the melting and pouring.

His school work has taught him keenness to see, to understand and to recognize possibilities. His molding experience has taught him the direction in which he must look. His chemical laboratory and pyrometer now come in use to collect the facts and to record the conditions of each cast. This information is accumulated rapidly, is arranged and catalogued according to the size of casting made, the quality of the metal, and the purpose for which the casting was designed.

To make this scheme a success, there are a number of points that the manager will naturally look out for. He will direct the young man to put himself under the foreman's guidance, to seek to satisfy him in every way, and will caution him not to try any experiments until he has collected many facts, to begin experiments cautiously, not running risks of too great a jump in the dark.

The experiment tried in The Builders' Iron Foundry of Providence of putting college students into the molding shop during the vacation is a good one, and will undoubtedly develop some first rate men. Men from high-class scientific schools would, however, in my opinion reach the goal quicker and with equally good or better final results.

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The placing of pattern making and foundry work in the curriculum of a school is good where the result sought is the mechanical engineer. I do not favor it, however, for turning out metallurgists for foundry work. First, because it can be better learned in the foundry, and secondly because the time consumed by it at school can better be devoted to other training, which the foundry cannot give. It is therefore in a sense, time wasted.

The graduates of the best schools of metallurgy of to-day, with a course of shop practice at the works either in vacations or after graduation, will be found admirably fitted to pursue this vocation and to bring it to a high state of development.

This is not a theoretical opinion, it is a fact proved by several graduates of the scientific school in which I am interested.

WHAT ARE IMPROVEMENTS?

By P. R. Ramp, Aurora, Ill.

Many articles have been published referring to improvements in the foundry, our mechanical papers are well supplied with illustrations and descriptions of improved materials and appliances. With so much of the product of man's genius at our command it seems incredible that we have not reached perfection.

When we look around us and see the many devices invented to save labor and time, we wonder what would be an improvement in our shop, because we must realize that what would be an improvement in one shop would be a failure in another, that is to say, it would not be a paying investment to erect a twenty-five ton traveling crane in a shop making two ton castings.

The first improvement required is a practical mechanic as manager, one who is capable of making improvements and seeing that proper results are obtained. For a man not familiar with the trade in detail is often led to believe that the molding machine he has recently purchased is not a success, and if it is allowed to stand idle so much money is thrown away. On the other hand, the practical man takes a hold of the same machine, if it can be operated successfully and his men do not succeed at it, he will enlighten them.

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This instance does not only apply to molding machines, but any improvement put into a foundry. A man like this would not depend upon the ability of the men under him, but is governed by his mechanical experience, proving himself a master of his business; he is competent to develop, or in other words, make men by giving them practical instructions in the trade.

Considerable improvement can be made in the method of making and using the flasks in many shops. The practice of compelling molders to use old flasks, with the joints badly burnt, in order to save lumber, is not a principle of economy; one who does so generally has to pay for it. A few hundred feet of lumber will often save many thousands of pounds of castings from the scrap heap, that is, from the time a job is put in the sand until the order is filled, the loss in bad castings will often be fifty per cent greater than when the molder has a good flask. A good flask and a pattern properly constructed will not only make it impossible for the molder to blame the flask for any carelessness on his part, but will make it possible for one with less experience or a cheaper man to do the same work. So we see a good flask is as essential in molding as a good pattern. Strong, well made flasks cheapen the product by reducing the loss in bad castings and increasing the output often to a very gratifying extent.

It is poor policy to patch up a flask. If you have an order for ten castings and the profit on the first one will pay for the material to build a new one, build it. You may lose one-tenth of the profit, but you are liable to lose more than a tenth while using the patched up affair.

Temporary makeshifts are dangerous and often expensive. In a shop where there are many standard jobs and the work is heavy, as in railroad, machinery, etc., my experience has shown it is much cheaper to make iron flasks.

Then the shop should be equipped with a good trolley system, a trolley track over each floor. The flasks that are too heavy to lift by hand should be handled with an air hoist suspended from the trolley. Such flasks must have trunnions cast on them, so that with the aid of a bail the molder will be relieved from all heavy lifts.

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Iron flasks cannot burn out at the joints. When they become obsolete they may be broken up and remelted, whereas in case of wooden flasks they are of no further value.

Considerable time might be occupied in discussion of this subject, but in summary will say, strong, substantial and practical foundry equipment, in charge of one thoroughly versed in the same, cannot fail to come under the head of improvements.

FOUNDRY MANAGEMENT.

By Jos. A. Murphy, Elizsbethport, N. J.

Few men run foundries for the good of their health; they, like every other branch of industrial enterprise, are run to make money—not for the pig iron and coke dealers, foundry supply merchants, or the help that is necessary to conduct them (though in many cases the lion's share of the profits go to the above mentioned), but for the owner's own pecuniary profit. Upon this theory all start out with more or less of a flourish to do business, and our success depends upon our plant and its location, management, material and tools.

Granting that the location is all right, the architectural design of a shop has much more to do with its efficiency than is generally supposed. Light is the all important thing that is wanted on the foundry floor, just as much as mental light is wanted on foundry subjects by a great many. Sand is a bad conductor of light, and everyone knows it. Then why is it so many foundries are almost dark, You would not expect your typewriters to produce a letter free from typographical errors if the keys had to be touched in semi-darkness. Your bookkeeper would not attempt to balance or make entries in your books under the same conditions. The chances are everyone in your office has an incandescent lamp over his desk to turn on when needed. An office force is to a great extent unproductive, although a necessary expense. All the more reason why you should give the productive portion of your employes at least as much light as the unproductive. Do you think a molder can do as much work in semi-darkness as he can

with good light? Don't you thing it takes time endeavoring to turn the sunny side of an old oil torch on some particular part of a job, ramming with it, setting gaggers with and finishing a mold with its aid? Bad light is very irritating to a molder, and many the time after he gives some portion of his mold a few slicks he will say, "Oh, let it go, can't see it without light." Rough and often bad castings can often be traced directly to bad light. Would it not be better, more healthy and more economical for all concerned to devise a means of conducting the free and pure light into the foundry, than to be every day large and indirect contributors to the scrap pile?

Simple matter to do it. The railroad stations furnish some splendid examples. Have a section of the roof made of wire glass and you will get the most satisfactory returns. I know of one foundry that admits light in that way, and the results are excellent. Light and ventilation are all important to the success of any foundry. These, with the total or partial abolition of the smoke nuisance, should be of prime consideration.

Much could be said under this caption that the limits of a brief paper like this necessarily curtails. My own experience being entirely in the machinery and jobbing foundries, I consider a competent foreman as the chief feature, one who himself is a first-class all round molder, not one who is first-class in some special kind of work, as a man who has had experience in only one or two shops in his lifetime is very apt to be. Avoid the specialist, as he is of necessity a one faculty man who is liable to prove himself a white elephant in any shop where the class of work is continually changing. A man of broad experience, good education and address, temperate in habits and language, firm and polite in his demeanor, generally is a student of human nature and has executive ability of a broad gauge character at his command and is sure to produce the very best paying results in any shop that is fortunate enough to employ him.

Men can be led much easier than driven. For polite requests, kind answers and gentlemanly bearing of a foreman, men will exert themselves to the utmost to do the square thing and to

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oblige. Men will always kill time on the bulldozer if they can. I have worked in shops where the foreman cursed and blasphemed nine hours out of ten, and who created so much confusion around casting time that one-third of the shop's work was always lost. Such foremen are cordially hated by their workmen, and in good times, such as the present, they cannot get good men to stay. Result, more bad work and more loss for the owners. Every man kills all the time he can, and is actually glad in his heart when castings get lost, so as to get the tyrant into trouble.

On the other hand, there are many shops where the foremen are greatly respected by their men and there is no length to which they would not go to help him get his work out. You never hear good foremen yelling and shouting, and as a consequence the men don't shout either. You never see any confusion around casting time—that particular time when every man wants to have his head about him. You see very little work lost in such shops, and you invariably see the maximum quantity of work turned out. I ask you the question, which of the two classes of men are likely to make your shop pay the best, the cool-headed, educated gentleman with his system always, or the blatant rule-of-thumb fellow with no system but his "hollering," fretting, fuming and growling?

You want the greatest possible amount of work you can get out of your men; that is natural. The more work you get out of each and every individual, the bigger and better your bank account grows. Now, what do you do towards that goal? Many of you do what is right, of course, but there are quite a number who do nothing at all other than sing out from the office, "We got to have more work." Did it ever occur to you that every molder in your shop spends over an hour every morning in the year doing laborer's work, pulling out castings, cutting sand, mixing facing, etc., and many other hours during the day skirmishing around after gaggers, parting sand, rammers, brushes, riddles, and fixing up old flasks that should be fixed before the job was given out?

Cutting sand in the morning is a bad appetizer for a square

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day's work. It is the hardest hour of the day, and a tired man means carelessness, and the chances are you may have an addition to the home-made scrap pile that you would not have had the molders been feeling as a man should feel about his responsibilities. A tired body always carries an inactive mind. You would be more in pocket to keep a molder molding. Castings are money to you. If the conditions of your shop are such that a molder cannot start molding before 8 o'clock, why, you have lost the equivalent in value of the castings that he would have produced in that one hour. Laborers should do that work. Some of you no doubt will say, "Well, if we did get the sand cut up our molders would not do any more work anyway." Why? let me ask. What is he going to do with that extra hour you gave him which is to his benefit as well as your own? If you can't get as much molding done in that hour as in any other, it bespeaks bad management for which you can blame none but yourselves.

You pay a molder 30c an hour and a helper 15c on an average. For every hour you keep a molder doing laborer's work you lose 15c on time alone, not to speak of the profits on what he would have produced in castings. If you have 50 molders each doing an hour of laborer's work every morning, you lose on time $6.50 per day, $39 a week, or over $2,000 a year. That would pay a good foreman. You will also probably say, "That sounds nice as a theory." I have seen it in actual practice in more than one shop, and know that it pays. All it requires to get it in working order is a foreman in sympathy with the movement and with executive ability enough to inaugurate a system. If you are not making the money you ought to make, just look into this matter. A small expenditure at the start will pave the way to a system of general economy. I know of shops where molders do not do five hours actual molding. Does this pay? The molders don't like it; they often leave, as they say they can't get anything to work with, so, figuratively speaking, it is bad for master and man.

There are true and false economies, and it takes a practical man to discern the difference between the two. Anyone can see

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it sometimes. The one aim in every foundry should be for a system. You would have less bad molders if you made an earnest endeavor to improve them. The great majority of them don't read; they are of a mechanical nature. A number of you are not very far advanced as far as reading matter of interest to the foundry is concerned. The molders' mechanical and intellectual improvement will surely be to your benefit. Do you do anything in the matter? I have never known of it.

Sand should demand the greatest care in its selection. A good, strong, refractory open sand is of prime necessity in any foundry, for with poor sand much time is lost and many castings as well. A deal of time is lost in venting work which would be unnecessary in many jobs with good sand. Scabs, even if they do not spoil a casting entirely, look bad and cost money to chip off anyway. It is more difficult than many of you imagine to keep bad sand from scabbing, and cutting where the flow of the metal is greatest. I have worked in shops where with ordinary care a casting never scabbed, and again in others, with extraordinary care castings often were covered with scabs.

About the first thing a new molder will ask his partner when he starts in a shop is about the sand. If told it is bad, he invariably spends more time on his mold, and any molder who has had experience in a good many shops is always ready to admit that it takes him a week or more to get on to its eccentricities. There are many dead losses in the foundry through the medium of bad sand. The difference in price between good and bad is very little, but the difference in results, if figured up, would be astounding.

Dry sand should be better understood among foundrymen. Castings are rarely lost in dry sand if handled by competent men. It costs a little, of course, to dry a mold, but with scarcely any risk of loss and a better and stronger casting goes a long way in compensating for the little extra cost. It is an open question whether in many classes of work dry sand is not the cheapest, all things considered. A dry sand mold is always made quicker by a man that knows his business, and the materials used need not be

half as costly as they sometimes are. Sweeping work is a good and cheap method which many of our foundries do not practice. They let good jobs pass their doors. Work can be swept up in green sand, dry sand and loam, but of course a knowledge of drawing is necessary on the part of the foreman and molder. Loam is often the cheapest way of making some castings, and the bricks should be of a soft quality and the sands of a good grade. Some shops go to a great deal of unnecessary expense in making loam. As good a loam as I ever used was composed of five parts loam sand and seven parts fire sand, wet with clay, wash well, mixed and left lay for a day or two before using. Horse manure, sawdust and the like make it hard to mix, hard to finish, and are unnecessary as component parts of loam mixtures.

Every foundryman tries to get pig iron suited to the class of work he turns out, and generally the best suited to that purpose. Great attention is often paid to the iron. Physical and chemical tests will be made, which will prove all right, but still the castings come hard, spongy, brittle, and often crack. Iron is easily spoiled in the cupola. We pay for good iron and endeavor to see that we get what we pay for, devote a lot of our time compounding mixtures and pay no attention to the quality of our fuel. I have known shops to have the best of iron and get poor results. The reason is often found in one single lump of coke. You may discover some yellow spots plentifully distributed all through it. That's sulphur, and a mighty poor thing to come in contamination with melting iron. The fuel should be examined for defects just as severely as the iron.

Plumbago blacking, it seems, is only a memory. Molders hardly ever see or handle any nowadays. Substitutes have largely taken its place, for, like any other article that is dear, a substitute is sure to be provided. The blackings of the present day are composed to a great extent of common cement, pulverized anthracite, charcoal, soapstone and other cheap minerals, and it is a question if they do not cost more than they are intrinsically worth. Some of them peel very well indeed, but the great majority of cheap blackings do not peel well and are difficult to

work on a mold. It would be worth while for someone statistically inclined to figure out how much longer it took a molder to properly slick up a mold—if such a thing is possible—with a poor blacking than if he had a good quality, and see if the difference in time, not to speak of the results, would not buy a good article. Castings are certainly much harder to clean with poor blacking. If the sand fuses—as it is sure to do on heavy work—a very bad job is the result, and in addition to the molder's extra time on the mold it costs more to clean the casting, and then the results are not fully satisfactory to anybody concerned, oftentimes resulting in the loss of a valuable customer. Every foundryman should strive for that which will give his shop the name of turning out the best and nicest castings in his vicinity. 'Tis a kind of policy that easily pays, particularly shops that handle machinery castings.

Assuming the fact—which is not always the case—that every shop is equipped with appliances commensurate with the financial circumstances of the firm, we will leave that matter at present and devote a few moments to the more common, every-minute, indispensable tools used in the shop, and of which there exists such a plentiful scarcity in many foundries. Shovels, riddles, brushes, rammers, clamps, gaggers, rods, wedges, weights, etc. To get the maximum amount of work, or to expect it, a man should have access to the above tools without looking around the shop for them or waiting until someone else is done. Every molder should have at least a good shovel, two riddles, a pail, a brush and a rammer, and if it is necessary—as is sometimes the case—hold each man responsible for their condition and safe keeping, but if you do, add in a proviso to discharge the first—and all after the first—person stealing any of the above articles.

The other things are more generally held as common property, and any shop is money—and a good deal of it—in pocket to have plenty of them. Have you ever seen a molder wait an hour until someone else was done with a rammer? Have you ever seen him wait until the last minute until someone else got poured, so as to get the clamps, not half clamp his job, have it run out, burn the flask and lose the casting?

Ever see a man a whole hour hunting up a handful of gaggers that someone else had buried in the floor for safe keeping? Probably you haven't. Probably if you did you would not notice it. In some shops this hunting around and waiting for everything is a necessary detail of the business. It does not pay, and I challenge contradiction.

Though you may think you are running cheap, you are running dear, and you would find that it would pay you better and your molders would like you the more, if you kept them molding instead of having them chasing around after the tools you should supply them with. For a scarcity of clamps, gaggers and such tools as can be made without scarcely any cost in the shop, there is no excuse other than that of bad management.

FOUNDRY FLASKS.

By Eli H. Pierce, Baton Rouge, La.

A good flask is the molder's friend and the proprietor's profit. I believe that more castings are lost through poor flasks than any other appliance in the foundry; more so is this true in the jobbing than in the one devoted to specialties..

Going into a jobbing foundry, we will find good cranes, cupolas, ladles, etc., while a visit to the flask yard is likely to set our thoughts agoing.

Here we will find flasks six feet square made of 1½-inch lumber, with bars of 1-inch stuff. Many of the latter will be burned or cut out, thereby causing them to be weaker than they were originally.

The corners of the flasks will be simply nailed together and not re-enforced with through bolts or corner-pieces as they ought to be.

The pins will be of a weak, shaky nature, secured in place with screws in such a manner that they soon become loose and allow the flask to shift at the joint, causing an unsightly seam to appear on the casting if any part of the pattern projects into the cope; and in case of an irregular joint increasing the chances for a crush.

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In many places we will find a pin that is an abomination, and should not be called by such a respectable name as "pin." I refer to the taper "misfit' made of wood. Some foundries are so short-sighted as to think that they cannot afford to make an iron pin—still, one lost casting will pay for a great number.

While on the subject of flasks I must beg you to allow me to transgress a little and call attention to the bottom boards, which in many cases are made too light in the first place, and later, in their burned-out condition, are worse than useless, as they allow swells on the casting, and sometimes bring about a run-out. Yet we wonder that other craftsmen look on us with more or less derision.

The master mechanic in the machine shop desires a new machine made for some special purpose. He is careful to calculate the strain that each part of the machine must stand. He and the draftsman go over all the drawings and check up any errors that may exist.

How different have we conducted the foundry part of the work on that machine. When we received the patterns we did not stop to calculate the strain that would come on the bottom board when the flask was poured, nor did we very likely determine the strain exercised upon the cope.

Here is what we did do. We went to the carpenter and said: Make a flask 4 ft. by 6 ft. inside measure, cope 6 inches deep, drag 12 inches deep; make the side of 2x6 for the cope, and 2x12 for the drag; use 1 inch stuff for the cross-bars.

Such a flask will do the work all right when new, provided the drag is secured with good cross-clamps to prevent the casting from swelling in the center; but after it has been used several times, then the trouble begins.

The writer does not claim to be any exception to the rule, and must confess that the rule of thumb holds a prominent place in his calculations; but he tries to use it in such a manner as to generally land on the safe side.

During my foundry life I have learned by bitter experience that every time a flask is used it becomes weaker through burning

and the rough usage it receives in shaking out. Being generally stored outside where the weather can play havoc with it causes it to grow weaker with age.

When ordering a new flask I always consider that it is to be used more than once, and make provisions for this by having the lumber heavy enough to more than stand the strain even if no bolts were used. Besides, I am careful to have good, heavy bolts in the cope, and also in the drag when the shape of the pattern does not interfere.

Being situated where cypress lumber is $18.00 per thousand feet, a little extra lumber in a flask is a small item with us. The following tables show what I find the proper size to use; and while some may think them heavy, I am inclined to believe that this kind of construction pays in the long run.

The bars should not be further apart than 8 inches from center to center. These tables are based on the supposition that copes and drags are 6 inches deep, and for every additional 6 inches of depth of either cope or drag add 25 per cent to the thickness given for that size flask in the table.

Square Flasks.	Sides.	Bars.
24-in. and under	1½ in.	1 in.
24-in. to 36-in.	2 in.	1¼ in.
36-in. to 48-in.	2½ in.	1½ in.
48-in. to 60-in.	3 in.	1½ in.

Rectangular Flasks.	Sides.	Bars.
18-in. x 48-in.	2 in.	1 in.
18-in. x 60-in.	2 in.	1 in.
18-in. x 72-in.	2½ in.	1 in.
18-in. x 84-in.	2½ in.	1 in.
24-in. x 48-in.	2 in.	1¼ in.
24-in. x 60-in.	2 in.	1¼ in.
24-in. x 72-in.	2½ in.	1¼ in.
24-in. x 84-in.	2½ in.	1¼ in.
36-in. x 48-in.	2½ in.	1½ in.
36-in. x 60-in.	2½ in.	1½ in.
36-in. x 72-in.	2½ in.	1½ in.

36-in. x 84-in.	2½ in.	1½ in.
48-in. x 48-in.	3 in.	1½ in.
48-in. x 60-in.	3 in.	1½ in.
48-in. x 72-in.	3 in.	1½ in.
48-in. x 84-in.	3 in.	1½ in.

The square flasks, sizes 24-in. to 36-in., should have one row of short cross-bars running through the center of flask, connecting the long bars that extend from side to side. Sizes 36-in. to 48-in. should have at least one cast-iron bar, preferably two, and should also have one row of short cross-bars. Sizes 48-in. to 60-in. should have at least two iron bars, and two rows of short cross-bars.

In the rectangular flasks we need no connecting bars until they become 36-in. wide; then they should have a row of short cross-bars running lengthwise of the flask. Those over 60-in. long should have one cast bar crosswise in the center. Flasks 48-in. wide should have two rows of short cross-bars and two cast bars equal distances apart and from the ends of flask.

All copes should have a ½-in. bolt running from side to side at each end, and where the cope is longer than 3 feet it should also have a bolt in the center. When copes are more than six feet long, the bolts should be spaced about every 2 feet apart, and all bolts should have a large washer on each end.

Drags should also have bolts at each end; but as conditions often prevent their use in the center, I would advise the use of a stout, long-nosed clamp placed crosswise of drag every 18 in. or 24 in., and securely wedged.

At the risk of being taken to task on the subject, I will say that all guide pins should extend up the side of flask at least 2 inches, and be bolted on with bolts not smaller than 5-16 inch in diameter.

I am well aware that many foundries never think of fastening pins on with anything but screws; but these will become loose in time and, being rusty, it is impossible to get them to take a fresh hold, while with a bolt, two wrenches will either tighten the pin or break the bolt.

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THE REAL FUEL RATIO.

By L. C. JEWETT, North Attleboro, Mass.

There has been a great amount of discussion in the past and is at the present time as to the amount of iron which should be melted with a ton of coke. Cupola builders have been in the habit of setting forth seductive claims as to the advantages in this respect for their cupolas. It is not uncommon to find heats mentioned where eleven to one has been melted, and this will go as high as thirteen to one in the claims for some makes of cupolas. To use more than this amount of coke in melting iron is by these people made to look akin to robbery. Proprietors, particularly those who are ignorant of practical foundry management, have been incessant in their demands upon their foundry foremen to reduce the item of fuel, regardless of any conditions under which the shop might be working, and whether the castings made are heavy or light.

To illustrate what takes place in an effort to reduce the fuel ratio, I have appended a conversation (an actual occurrence) between the superintendent and foreman of a prominent foundry:

Superintendent: Can you give any reason why we cannot melt iron as cheap as they do over at our neighbor's foundry? They say they are melting from ten to ten and a half pounds of iron to a pound of coke right along, while your reports show that about eight and a half of iron is as high as you get. Your blast is just as the cupola builder stated it should be. Now, if you haven't a good melter, fire him and get another one. If you haven't wind enough, we will speed the engine up or change the pulleys. Do not overlook the fact that we must run our foundry as economically as others in order to prosper.

Foreman: Considerable can be said as to what is economical in the management of a foundry or cupola. With all regards for the interests of this company, and due respect for the managers of our neighbors' foundry, I wish to say that I have always believed the real economy in melting iron lay in having it hot enough. If it comes too hot to pour at once, it can easily be chilled,

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but if too dull, it is impossible to increase its temperature. When iron is melted hot, the various grades mix better, it is sure to run the work all around, it gives more time for the molders to pour their work understandingly, there is less waste, and the ladles are left in better condition. A foundry foreman is ever on the alert to know the conditions of the melted iron from the first to the last, or at least he should be. He is also in a position to know from the working of the cupola whether there is too little or too much fuel used at any stage of the heat. Over at our neighbor's foundry, there is a far different class of work from what is made here. Eighty per cent of their metal is handled with crane ladles, while here we have conditions exactly opposite. When iron must be poured from a small ladle, and several molds from the same ladle, it becomes absolutely necessary to have the iron hotter than if the metal could be handled in large quantities, since its temperature falls very rapidly in small bodies, and brings the molder still nearer the ragged edge of uncertainty. However, I am not egostistical or prejudiced in the least; I have no desire to use anything with extravagance, and if we can get iron sufficiently fluid with less coke, without wasting more at the bung than is saved at the spigot, you will never know a more appreciative pupil than your present foreman.

The upshot of this interview was that an arrangement was made to try our neighbor's formula for melting iron in our cupola. At the first trial, the first part of the heat came down quite hot, but when half through, the iron became duller and the ladles began to bung up, the molds were not all poured off and all small ladles had to be relined the next morning, besides one crane ladle. After viewing the results of the experiment, it was decided to speed up the blower the next day, and also to change the amount of fuel and stock so that the charges would be lighter. On the second trial, the cupola melted somewhat more even, but the ladles were all bunged up before the heat was ended, and the molders were doing that reckless pouring so noticable in all shops where dull iron is the rule, and where it is a common occurrence to see a molder pour a sprue hole, even when he

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knows that there is not the least chance of the iron running half of the casting.

The third heat was a repetition of the second, with a frantic rush by the molders to get the iron out of the ladles before they should get bunged up. The result of these three heats was any number of defective castings. Some were strained, others were cold-shut and many were poured short. Extra help had to be put on to prepare ladles and take care of the increased work around the cupola.

On the fourth morning, the foreman sent for the superintendent, to whom he said: "I am beginning to learn how to melt ten to one, and I want to know whether you want to continue in this manner."

Superintendent: What is your opinion of the scheme?

Foreman: Just the same as before we started experimenting, that iron can be melted ten to one is beyond dispute, but it makes all the difference in the world what kind of work it is melted for and how rapidly it can be handled after leaving the cupola.

I have arranged a table of the different fuel ratios based on heats of twenty tons a day and coke at four dollars per ton:

Coke.	Iron.	Cost of Fuel for 20 Tons.	Cost of Fuel Per Ton of Iron Melted.
1 to	6	$13.33⅓	$ .66⅔
1 to	7	11.43	.57¼
1 to	8	10.00	.50
1 to	9	8.89	.44½
1 to	10	8.00	.40
1 to	11	7.27	.36⅔
1 to	12	6.66⅔	.33⅓

We have run in this improved way three days, melting more than sixty tons of iron on the ten to one formula, and we have secured theoretically above any previous average a saving of $2.00 per day in fuel. Against this, we have to charge the outlay for extra help to daub ladles, the material (mud and fuel) used for same, the castings that have been lost, and what is worse, the irritating effect produced upon the workmen. It may not be known to you, but it is a fact nevertheless, which any molder

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will tell you, that a ladle, however slightly bunged up with chilled iron seems much heavier to handle than the same ladle clean and full of nice fluid iron. Considering all these things, I ask you, "Shall we continue to save some two dollars per day on the charging stage and let six or eight go to waste on the floors?"

CRYSTALLIZATION OF METALS.

By EDWARD B. GILMOUR, Milwaukee, Wis.

It is almost impossible to overrate the importance of this subject with reference to the designing of castings, as no one can design a casting intelligently without a knowledge of the laws which are brought into play in the cooling of a casting. There are few subjects in the foundry busniess that have attracted so little attention and had so little written upon it, and the best information that we are possessed of has been got by bitter experience through castings becoming defective on account of bad designs.

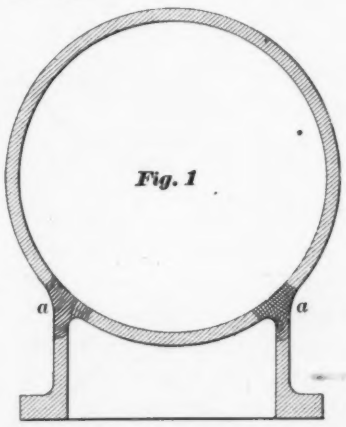

Fig. 1

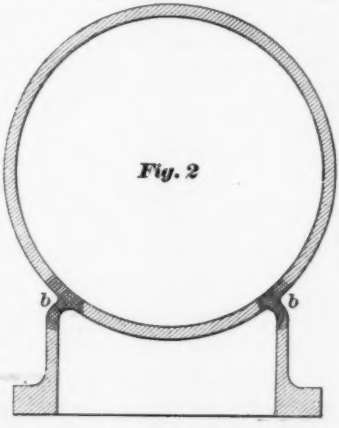

Fig. 2

I will endeavor in this brief article to give some incidents which have come under my notice. Before doing so it is necessary to refer to some of the laws which govern crystallization. What is understood by that term, in a general sense, is every

operation, or process, whereby any body is made to pass from a liquid or gaseous state to a solid, and assume a definable and regular form (that is in the grain). Crystallization is an accessory to slow separation. In metals this takes place in the process of cooling. All metals which are cast, when they change from a molten state into a solid, have crystals or molecules which rearrange themselves in a regular order, according to influences brought to bear upon them. The formation of these crystals depends on the constituent particles, and can only take place if the molecules posssess perfect freedom of motion. Generally when a body passes from a liquid or gaseous state to a solid, the crystals will take a definite shape resembling an octahedron, which is two four-sided pyramids united base to base. When the crystals are united in regular order all through the casting, without any

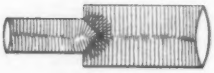

Fig. 3

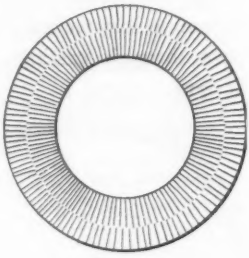

Fig. 4

weak planes, caused by the separation of the crystals, and which only occur on account of defective designs, a casting is at its strongest. Faulty designs have been a source of great trouble to the founder, and in a great many instances he is blamed for putting inferior iron into the castings. A regular formula has been used by the designer, who calculated that iron of such dimensions was strong enough to carry the load required. The practical foundrymen, more especially the steel founders, are watching the designs of castings and making the necessary changes needed to producing strong and good castings. Professor Mallet says of the formation of crystals:

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"It is a law of molecular aggregation of crystalline solids that when their particles consolidate under the influence of heat in motion, their crystals arrange and group themselves with their principal axis in lines perpendicular to the cooling or heating surface of the solid, that is, in the direction of the heat wave in motion, which is the direction of least pressure with the mass. This is true whether in the case of heat passing from a previously fused solid in the act of cooling and crystallizing on consolidation, or of a solid not having a crystalline structure, but capable of assuming one upon its temperature being sufficiently raised by heat applied to its external surface, and so passing into it."

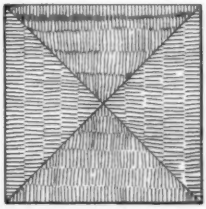

Fig. 5

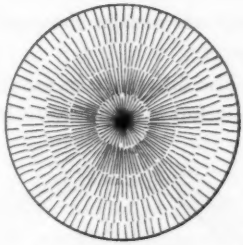

Fig. 6

Cast iron is a crystalline matereial which in consolidating obeys the laws pretty perfectly, the lines of crystallization running perpendicular to the external surface or in the direction of the heat wave passing from the body in cooling, so that if there is not even thickness in construction the crystals will run towards the point of cooling first, and heavy parts being longer in cooling will be subjected to a very heavy strain, which will cause a weak plane diagonally right in the center of the heaviest part of the metal. Take, for instance, Fig. 1, which is a cross-section of a slide-valve cylinder, right through the center of the exhaust; the point marked a a is the usual system in making the casting, with regular even fillits on the core and evenly rounded on the outside. The design looks all that could be desired at first sight, but in practice and theory it is unquestionably wrong, as the heavy body of metal at this place is longer in cooling than at each

side, and the crystals are formed in opposite direction to each other, causing a weak plane where the ordinary observer would expect it to be strongest, when in reality it is the weakest part of the cylinder. With a number of castings of this design we had a troublesome experience. After the engines had been delivered and were running, in a great many instances the cylinders cracked at the point shown, and the first one that gave way caused a legal controversy on account of the quality of the metal; but when, with the repeated occurrences of these breakages, the builders' attention were drawn to the construction, the result being a change in design to Fig. 2, b b—which is in accordance to the laws of crystallization—and resulted in neutralizing all the hard epithets which are usually showered upon each other under such circumstances.

The difference in design and the change in the order of crystallization is readily seen in this illustration.

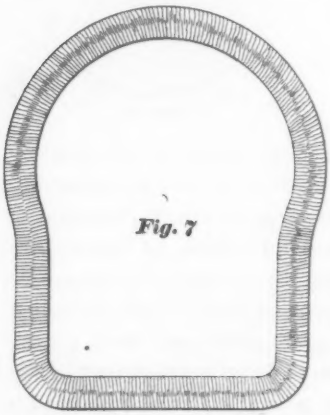

Fig. 7

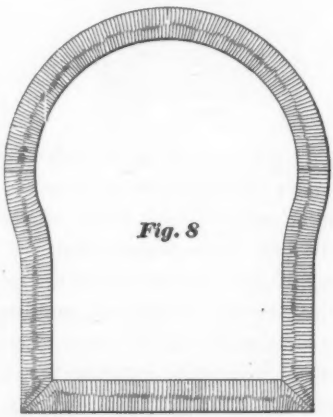

Fig. 8

Fig. 3, c c, shows an arrangement of crystals which causes a weak plane to run into the heavy part. Fig. 4 is an example of crystal arrangement which is very definite, and is of the strongest nature. Fig. 5 is a flat plate section with crystals following a regular order radiating from the inside, with the exception of a diagonal weak plane—which usually causes the outer edges to raise

up and make a twisted plate. In order to obviate this trouble it has been found expedient to cover the whole surface of the casting with about 3 or 4 inches of sand, afterwards take a rammer and strip the sand upon the diagonal lines, which will cause the casting to cool quicker at this point and change the crystals into a regular form throughout the casting. In no case should flat plates ever be cast with hard iron, for the reason that in hard iron the crystals are more pronounced than in soft iron. Fig. 6 is a round bar which shows the crystals all radiating from the center in regular order. Fig. 8 shows an arrangement of crystals in a set of building plates, which were made to strengthen the building of cylinder molds. We had a number of these castings to make, and our intention was to use the same plates for each mold, but they always split diagonally at the corner after the cylinder was cast. I therefore made a change in construction, which completely re-arranged the crystals, as is demonstrated in Fig. 7, and gave the desired result of saving them every time. It will be apparent from the illustrations that any one having charge in the designing of castings should give particular attention to such points as are set forth, and avoid all unequal thicknesses or sharp corners. Although many castings may be made which will not show any particular defects in a marked degree, because if they are exposed to great heat the crystals will re-arrange themselves, as has already been demonstrated, from the entering and returning of the heat waves, and the greater the heat the more easily will the above laws be obeyed. Consequently, if the designer is familiar therewith, the founder will be saved much money and time—also a great deal of anxiety and trouble. The molder before pouring his work should be cautioned to look after his iron and see that it is of the required temperature to suit the work; for the heavier the piece is the cooler should it be poured, as the development of crystals depend upon the regularity of the cooling of the casting, and dull iron always makes stronger castings because the crystals are better defined. However, this does not always make clean castings—so that after all, the molder has got to use discretion in order to produce the best results.

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THE MIXING AND MELTING OF IRON FOR HYDRAULIC WORK.

By R. P. CUNNINGHAM, Holyoke, Mass.

The mixing of iron for castings used on hydraulic work, or any casting that is required to stand a great pressure, has never received the attention it should have by the average foundryman.

It is a common occurrence in shops where hydraulic work is cast to have trouble with castings leaking. What I mean by that is, when the machine is put on the test it will not stand the pressure, and water will come through the casting.

This is very aggravating, besides being very expensive, as the machine work is sometimes four times the cost of the casting; and to have the casting and the labor charged back to the foundry is something that the foreman does not relish, and very often he is not to blame for the defective castings, as he had done everything he could, and the only blame that could be laid on him is that he should know his iron. If he had, the result would have been different. As it was, he tried to do the best he could with what he had, and his failure should be divided with those who compelled him to use iron entirely unfit for the work required.

In the best managed foundries the metal sometimes goes astray, and the unpleasant experiences which soon follow are decidedly painful. Often hundreds of dollars are lost; the foreman is called into the office and is shown letters from the firm's best customers, complaining about the castings; he is at a loss to understand the cause; his reputation is at stake. Upon investigation he is more confused than ever. Everything was conducted as usual; every rule he laid down had been followed; and yet these breaks occur, and are difficult of explanation. Every one admits that something is wrong, but how to locate the trouble? The answer is easy. Chemistry is your only relief, with its certainty of result.

If you should want a nice piece of wood-work done, would you insist on using an inferior wood, or would you allow the wood-worker to select the wood best suited for the work? If you

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wanted a special tool made, would you insist on your blacksmith using a cheap steel, or would you allow him the privilege of using his own judgment, and select the steel best adapted for this particular piece of work? The foundryman should know his iron as the woodworker knows his wood or the blacksmith knows his steel. He should be able to tell you at once the kind of iron required for any kind of work. This information can be easily obtained by an analysis of your irons.

We will take the six principal elements found in iron, namely: Silicon, Sulphur, Phosphorus, Manganese, Combined Carbon, and Graphitic Carbon.

Let us see what effect these different elements found in pig iron will have upon the castings.

Beginning with Carbon. It has more influence on the physical characteristics of cast iron than any other; and within certain limits the influence of the various other elements are exerted not on the iron itself, but on the Carbon.

According to Fresenius there are four forms of carbon present in cast iron, but only two are well-known, i. e., graphitic carbon and combined carbon. In the total carbons in any one iron there is not a great variation; but the results on the relative amounts of the two on the strength and appearance of the iron are enormous. The higher the carbon, the weaker the iron. Graphitic carbon renders iron soft; but, owing to its disturbing elements, is low in tensile strength. Its disturbing continuity arises from the fact that it is simply an inter-molecular and not a true chemical combination, as is combined carbon. Iron high in combined carbon will have greater strength. The remelting will change graphitic carbon into combined carbon, and increase the strength and density of the iron.

Silicon. This element in iron is better known than any other. Its effect on foundry iron is that of a softener, i. e., it turns carbon into the graphitic state, owing to its great power over carbon, from which it is impossible to separate it. It is hard to tell just what its influence is on iron; but it is considered that anything above two per cent weakens the iron.

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Sulphur turns graphitic carbon into the combined state, and makes the iron closer grained; but, in a casting with uneven thicknesses, liable to crack. This can be overcome by melting the iron hotter, as the hotter the iron the lower the sulphur and graphitic carbon. A small amount of sulphur is not objectionable in iron used in casting hydraulic work, as an iron to show great strength and density should contain from 0.03 to 0.05 per cent. It should not be forgotten that coke contains a large amount of sulphur, and iron readily takes it up—and often the iron is condemned when the fault is with the coke. Therefore, one can readily see it is as necessary to know the analysis of your coke as your iron. It is a well-known fact that some of our best coke contains 0.50 per cent of sulphur, and some even higher. For this reason you should have the sulphur as low as possible in the iron.

Phosphorus. This element has a tendency to convert graphitic carbon into the combined state, but owing to the greater effects of silicon and sulphur its influence is not so marked. On account of fluidity and a tendency to overcome shrinkage it is valuable in iron used in hydraulic work, as in most cases with this class of work there is a large amount of cores and you are apt to have cold shuts unless the iron is very fluid. Another fact in this work is that the thickness is very uneven and liable to be porous unless the iron is fairly high in phosphorus, say from 0.50 to 0.80 per cent; but on light work it may run as high as 1 per cent.

Manganese, like sulphur, has a tendency to make iron harder and denser; but as most irons have very little of this element in their composition, not much attention has been paid to it—not as much as should be—for, owing to its chemical attraction for sulphur, it serves to carry off much of this element which would otherwise combine with the iron, the sulphate passing off in slag. For hydraulic work, iron containing from 0.40 to 0.60 per cent can be used to an advantage.

We will take the castings used in hydraulic work. They must be sound, close-grained, and free from shrinkage. Only those that have had experience in this class of work know how difficult

it is to accomplish. The exact chemical composition required in iron to produce the above castings should be determined and lived up to closely. It is only necessary to analyze your iron for the four principal elements, for it is a well-known fact that iron high in silicon is low in sulphur; and when silicon is low, manganese is low and sulphur is high.

In foundry irons you must watch the silicon, phosphorus and manganese in order to obtain satisfactory results.

In summing up, your mixture should contain from 1.25 to 1.50 per cent silicon; from 0.60 to 0.80 phosphorus; from 0.40 to 0.60 manganese, and sulphur as low as possible.

If you will take that for your standard, melt your iron hot, you will see a decided improvement in the quality of your castings.

There is another point that must not be overlooked. In foundries using a large amount of scrap, say from 25 to 40 per cent, there is no fixed rule that you can adhere to. I always keep the scrap from the machine shop and sprews separate, and use these in the first of the melt, pouring my best work from this iron. Take this in addition to what No. 1 scrap I can pick out of the outside scrap pile, and by letting the other go into the common iron, which I use only in work that is not required to stand a pressure and has little or no machine work on it. In doing this way it takes a little extra labor, but is more than offset by the quality of your castings.

The care and management of the cupola is another point which should receive its share of attention. The mortar used in repairing the cupola should be mixed with great care. If the mortar should run in the cupola, the first iron would come hard and dirty. For this reason you cannot be too careful with your mortar.

The different brands of iron and scrap should be thoroughly mixed in the cupola, and not thrown in at random. Each charge of coke should be put in even, and the whole kept as level as possible. The iron should be drawn into a large ladle, and from there into smaller ones. By doing this way your iron is thoroughly mixed, and good results obtained.

I am no great advocate of seeing how little coke I can use in

melting iron, for I claim more castings are lost by dull iron than any other way. An extra fifty pounds of coke on a charge will sometimes save hundreds of pounds of castings. especially in work that is thin in places and has a large amount of cores.

I have found by following these rules that I have increased the quality of my castings, and the per cent of good castings to the iron melted.

In conclusion I will say that there may be others that have just as good, and perhaps better, ideas than I have advanced in this paper, and to those I will say, let us hear from you on this subject. I am open to criticism, as it is only in this way that we get each others' ideas. By doing so we raise the standard of foundry work.

THE CUPOLA PRACTICE IN THE BESSEMER STEEL WORKS.

By S. M. Rogers, Pittsburg, Pa.

[Read at the June meeting of the local Foundrymen's Association.]

There is no essential difference in the construction of the cupola used in the Bessemer Steel Works and the cupola used in ordinary foundry practice. But the circumstances and conditions governing the proper manipulation of the former, from those of the latter, may be worthy of some consideration. In order that every detail of the discussion shall be better understood, the following drawing is appended.

The thickness of the lining from the bottom of the bosh to some distance above the tuyeres being about 24 to 26 inches is quite essential when a cupola is to be continuously operated for a whole week. Even this thickness is insufficient when the cupola is not started properly; or, when the iron is high in manganese the lining is rapidly reduced. The cupola is lined with the best quality of bricks, and all necessary repairs are made with any good grade of stone, using a mixture of five parts of ganister to one of clay.

The tuyeres in the Bessemer cupola are placed much higher above the bottom of the bosh than in the ordinary foundry cupola,

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the reason being quite apparent since there must be considerable space below the tuyeres to be used as a reservoir for the melted iron. The shape of the tuyeres seems to have little bearing on the consumption of fuel or rapidity of melting, so long as the proper volume of air is entering the cupola in such a manner as to cause complete combustion of all the fuel within or as near to the melting zone as possible.

The number of tuyeres depends upon the size and kind of cupola. The cupola herein described contains about 48 or 50 tuyeres, having a diameter of four inches on the outside, tapering to two and one-half inches on the inside.

The size and number of tuyeres seem to be largely matters of choice. However, it seems quite reasonable that the smaller the tuyeres, the more apt they are to be rendered useless by the fuel closing their inlets. Also the smaller they are the less the general distribution of the air, and the greater and more rapid are the fluctuations of the melting zone. The shape of the tuyeres does not seem to materially influence the melting capacity of the cupola, but their position may increase or decrease the depth of the melting zone.

The tuyere area should be at least two and a half times (2½) as great as the air conductors, and each conductor should be provided with a volume gauge in order that the melter may know that each cupola is receiving the proper volume of air for complete combustion of all the fuel. A change in the volume of blast entering a cupola, sometimes arising from the temporary closing of some of the tuyeres with fuel, must necessarily give rise to considerable fluctuation of the melting zone and thereby cause irregular melting.

When more than one cupola is being operated at the same time, and each receiving its supply of air from the same main, it is difficult to determine whether each is receiving its pro-rata of blast, unless each air conductor is provided with a volume gauge. The pressure gauge may show the required pressure, but it is in no sense a measure of volume. The absence of some practical means of measuring the volume of air passing into a cupola is a

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very serious difficulty in the way of scientific and economic melting.

Practical demonstration shows that, under favorable conditions, it requires about thirty thousand (30,000) cubic feet of air, or about twenty-four hundred (2,400) pounds to melt one ton of iron. When we realize what a large amount of moisture this volume of air may contain on a damp or rainy day, in addition to the quantity the fuel may contain when it is exposed to the weather, then we may more readily understand how seriously the operations of a cupola may be effected, and how readily a change in the burden may be required.

It would no doubt be surprising if we could accurately estimate the weight of water that enters a cupola under the above conditions, and the increase in the consumption of fuel caused thereby. It is also important to note that the more water the air contains the greater will be its oxidizing effect upon the iron, since eight-ninths (8-9) of its weight are oxygen, while in dry air a little less than two-eighths (2-8) are oxygen, it follows that the more moisture the air contains, the greater will be its oxidizing effect upon the iron. However, the cooling action of the watery vapor has a tendency to counteract its oxidizing effect, but much heat is absorbed by its decomposition.

When the proper quantity of air is supplied the combustion is perfect, and carbonic acid gas (CO_2) is the result. When the quantity of air is insufficient the combustion is imperfect and carbonic oxide (CO) is the result. The quantity of heat evolved in the two cases is as fifteen (15) to four and a half ($4\frac{1}{2}$), showing a loss of more than two-thirds ($\frac{2}{3}$) of the heat by imperfect combustion.

The loss of fuel is not all. Much iron may be lost by the oxidizing influence of the blast, a large amount of which is mechanically carried out of the cupola when the pressure of the blast is high, and part is lost through the slag hole. It is not always true that we obtain the most rapid melting when we are forcing into the cupola the largest volume of air. Some time is required to elevate the temperature of the air to the point that it will enter into combustion with the fuel.

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Any more air than is required for complete combustion of all the fuel, rapidly absorbs heat, reduces the temperature, retards combustion and the fire in the cupola may be entirely extinguished. When the blast pressure is high much of the fuel is consumed long before it reaches the melting zone.

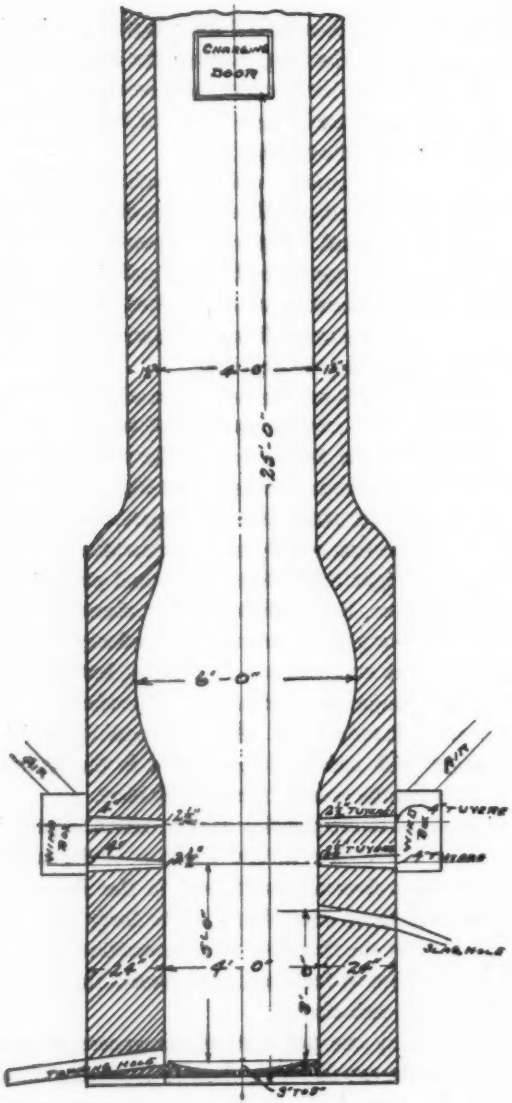
The cupola cannot produce molten iron in the proper condition neither chemically nor physically when the air pressure is too high and the volume too small. But with a pressure of from four (4) to seven (7) ounces per square inch, and a sufficiently large volume to produce rapid combustion of all the fuel, with the absence of all excessive tendencies to oxidizing influences in the melting zone, the very best results may be expected.

The melting zone is not the only place where iron may sustain injury and loss. The careless manner of tapping the slag often results in exposing the molten iron to the oxidizing influence of the blast, which is always greater under high pressure than low, as well as to cause the absorption of oxygen and other gases, and thereby render the iron wholly unfit for certain castings.

At first we might think that carbon and phosphorus protect iron from oxidation, but in their peculiar chemical combinations in molten iron, they greatly increase the tendency to burn. Burning, however, does not seem to be oxidation, but rather the result of structural change, not necessarily dependent on oxidation, though possibly favored by it. Another condition which is sometimes fraught with serious consequences is the foaming of the slag, which is usually caused by too much blast.

We come now to the question of flux, which is quite important and deserving of the most careful attention of the melter. Limestone is almost universally used, and in the Bessemer practice usually requires from thirty-five (35) to forty (40) pounds per ton of metal. But the character and composition of the iron to be melted and the kind of fuel used must control the quantity of flux to be added with each charge.

Iron containing one per cent. of manganese or more, causes rapid action on the cupola lining, thereby increasing the amount of material to be slagged off, at the same time rendering the slag


CHARGING DOOR
4'-0"
25'-0"
6'-0"
AIR
AIR
TUYERE
TUYERE
SLAG HOLE
4'-0"
TAPPING HOLE
9"TOP

quite liquid. The plastic condition of the slag causing great difficulty in tapping, is the result of too little fluxing material. However, the proper use of limestone demands the exercise of considerable judgment, since too much as also too little produces a whiter, weaker and harder metal than when the proper amount is added. This is no doubt due to the de-siliconizing tendency of a strong blast with an excessive amount of fuel, supplemented by the absorption of sulphur from both fuel and flux.

Iron may also be seriously effected by the imperfectly fused state of the slag descending more or less mixed with the melted iron. In the Bessemer practice such a condition is not apt to effect the resulting steel.

In the Bessemer practice we must not forget that there are many circumstances and conditions which largely influence the proper management of the cupola, and that many of the difficulties are entirely unavoidable. To manipulate the cupola successfully means that all the parts of the plant must be in successful operation with as few delays as possible. However, it frequently happens that when the cupolas are in successful operation, that an accident to some part of the machinery may make it necessary to stop the blast, discontinue charging and retain the molten iron in the cupola till the damage is repaired. Should such a delay extend beyond six or eight hours, the contents of the cupolas must be dropped, which means considerable loss of time and material.

Then again, there are difficulties entirely local and not dependent upon the operation of other parts of the plant, such as a delay in the first appearance of iron at the tap hole, caused by too much fuel being added previous to the first charge of iron, thus causing the latter to remain above the melting zone till the excess of fuel has been consumed. Also any considerable variation in the pressure and volume of air will change the melting capacity, as well as the temperature of the melted iron. Now, in conclusion let me say that, while it is encouraging to note that within the past few years the application of science to the foundry practice has made rapid progress, yet the proper distribution of that science to each and every department of the foundry is sadly

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wanting. There is no doubt that if the cupola practice and the materials used therein were given the same careful and scientific consideration that our machine shops receive, the economic results would be astonishing.

In 1873 an eminent English authority stated: "If we could avoid the future of what may be designated unscientific practice, or the failure of impracticable science, we must seek to combine commercial intelligence with a knowledge of those laws which form the only trustworthy groundwork of the complicated processes in which we are engaged." Each day brings us nearer to the fact that the day has come when much time should be devoted to securing a more thorough acquaintance with scientific and metallurgical principles, and incorporate into the foundry practice as many well established facts as possible, remembering that applied science is but the application of pure science to particular classes of problems, while pure science consists in deducing general principles by reason and observation.

APPENDIX TO ACCOMPANY THE PAPER OF THE COMMITTEE ON STANDARDIZING THE TESTING OF CAST IRON.

CAST D—CHILLED ROLLED IRON.

This set of 48 bars, cast vertically and at the same time, in accordance with the specifications of the American Foundrymen's Association Committee on Standardizing the Testing of Cast Iron, furnished so far 48 tests; others are to follow later.

Cast D illustrates a class of castings which must be capable of resisting enormous strains, not only external, but especially those existing internally as a consequence of artificially chilling the surface and working at a high temperature.

This particular cast was part of the regular heat going into heavy chilled rolls, the iron used being entirely cold-blast charcoal.

Transverse bars were cast only, as no data of commercial value could be obtained from tensile tests, the material being practically white for the sections falling within the scope of ordinary testing machines.

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The bars were made by Mr. J. S. Seaman, and presented to the committee in the interest of the trade. The tests on the smaller sizes, as well as the analyses, were made by the Pittsburg Testing Laboratory. The heaviest sections were tested on the special machine of the Riehle Bros.' Testing Machine Co. This committee wishes to thank the members of both firms for their trouble and courtesy in presenting the results to the trade at large.

The nature of the iron precluded any machining, and the analysis of the one-inch dry sand bar is as follows:

Total carbon	2.36
Graphite	.06
Silicon	.85
Manganese	.15
Phosphorus	.482
Sulphur	.07

The fluidity strip ran up full, showing good, hot iron; the chill was $\frac{3}{4}$ inches deep. Compression tests are now under way and will be published as soon as completed.

TABLE NO. 1.

Series D.

TRANSVERSE TEST.

Chilled Rolled Iron—Bars in Green Sand and Not Machined.

No.	Approx. Cross Section. Ins.	Actual Size. Depth. Ins.	Actual Size. Width. Ins.	Breaking Strain. Lbs.	Deflection. Ins.	Contraction. Ins.
956	0.5x0.5	0.57	0.58	450	.200	..
957	1x1	1.04	1.06	2,810	.270	..
958	1.5x1.5	1.54	1.54	9,690	.265	..
959	2x2	2.04	2.06	22,250	.250	.17
960	2.5x2.5	2.50	2.46	47,880	.220	.16
961	3x3	2.93	2.94	73,900	.130	.14
962	3.5x3.5	3.48	3.48	97,100	.160	.14
963	4x4	4.00	4.00	174,460	.140	.12

TABLE NO. 2.

Series D.

TRANSVERSE TEST.

Chilled Roll Iron—Bars in Dry Sand and Not Machined.

No.	Approx. Cross Section. Ins.	Actual Size. Depth. Ins.	Actual Size. Width. Ins.	Breaking Strain. Lbs.	Deflection. Ins.	Contraction. Ins.
964	0.5x0.5	0.48	0.58	360	.240	.28
965	0.5x0.5	0.50	0.46	390	.280	..
966	1x1	0.97	0.97	2,250	.290	.27
967	1x1	1.00	0.99	2,400	.260	..
968	1.5x1.5	1.50	1.50	8,650	.280	.22
969	1.5x1.5	1.46	1.46	7,820	.250	..
970	2x2	2.00	1.98	25,210	.240	.16
971	2x2	1.95	1.97	20,720	.230	..
972	2.5x2.5	2.46	2.44	47,650	2.10	14
973	2.5x2.5	2.49	2.50	50,050	.200	..
974	3x3	2.94	2.94	74,100	.190	.14
975	3x3	2.99	2.98	84,900	.180	..
976	3.5x3.5	3.48	3.44	126,040	.180	.13
977	3.5x3.5	3.50	3.47	130,580	.190	..
978	4x4	3.92	4.00	185,600	.220	.11
979	4x4	4.00	4.00	193,220	.210	..

TABLE NO. 3.

Series D

TRANSVERSE TEST.

Chilled Roll Iron—Bars in Green Sand and Not Machined.

No.	Approx. Diameter. Ins.	Actual Size. Depth (d) Ins.	Actual Size. Width (d) Ins.	Breaking Strain. Lbs.	Deflection. Ins.	Contraction. Ins.
980	0.56	0.54	0.54	280	.225	..
981	1.13	1.16	1.13	2,460	.280	..
982	1.69	1.76	1.72	11,880	.270	..
983	2.15	2.26	2.28	25,130	.248	.15
984	2.82	2.79	2.80	48,650	.220	.14
985	3.38	3.40	3.38	84,200	.200	.12
986	3.95	3.92	3.96	126,360	.170	.12
987	4.51	4.50	4.51	201,020	.160	.11

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TABLE NO. 4.

Series D

TRANSVERSE TEST.

Chilled Roll Iron—Bars in Dry Sand and Not Machined.

No.	Approx. Diameter.	Actual Size. Depth (d)	Width (d)	Breaking Strain.	Deflection.	Contraction.
	Ins.	Ins.	Ins.	Lbs.	Ins.	Ins.
988	0.56	0.48	0.50	180	.210	.27
989	0.56	0.50	0.52	180	.230	..
990	1.13	1.10	1.16	2,410	.230	.24
991	1.13	1.09	1.10	2,020	.250	..
992	1.69	1.64	1.66	8,150	.260	.20
993	1.69	1.66	1.68	9,430	.266	..
994	2.15	2.24	2.20	29,570	.240	.14
995	2.15	2.25	2.20	24,840	.250	..
996	2.82	2.78	2.82	42,760	.220	.13
997	2.82	2.76	2.78	45,240	.200	..
998	3.38	3.34	3.36	63,800	.190	.13
999	3.38	3.36	3.36	63,700	.190	..
1000	3.95	3.88	3.88	118,720	.160	.12
1001	3.95	3.92	3.96	114,660	.150	..
1002	4.51	4.48	4.50	196,320	.150	.11
1003	4.51	4.47	4.50	178,040	.140	..

CAST E—SAND ROLL IRON.

This set of 44 bars, cast vertically and at the same time, in accordance with the specifications of the American Foundrymen's Association Committee on Standardizing the Testing of Cast Iron, furnished so far 44 tests; others are to follow.

Cast E illustrates a class of castings which must resist great bending strains while in a heated condition, as for instance in rolls for structural and merchant material. This particular cast was part of the regular heat going into large sand rolls. The iron was warm blast charcoal.

For reasons similar to those given in the memoranda of Cast D, bars were made for transverse tests only and none were machined.

The bars were made by Mr. J. S. Seaman, and were tested and the iron analyzed by The Pittsburg Testing Laboratory and the Riehle Bros.' Testing Machine Co., the material and data being presented to the committee in the interest of the trade. The thanks of the foundrymen are due in return for these courtesies.

The analysis of the one-inch dry sand square bar is given herewith:

Total carbon	3.04
Graphite	None
Silicon	.72
Manganese	.17
Phosphorus	.454
Sulphur	.07

Though the fluidity strip ran up full, some difficulty was experienced with the smaller bars, several being lost. The iron chills very quickly, feeding in small section ceases and hollow heads result. Otherwise the cast was very satisfactory. The chill was 1 inch deep.

TABLE NO. 5.

Series E.

TRANSVERSE TEST.

Sand Roll Iron—Bars in Green Sand and Not Machined.

No.	Approx. Cross Section.	Actual Size. Depth.	Actual Size. Width.	Breaking Strain.	Deflection.	Contraction.
	Ins.	Ins.	Ins.	Lbs.	Ins.	Ins.
1004	0.5x0.5	0.51	0.52	400	.210	..
1005	1x1	1.02	1.03	3,070	.218	..
1006	1.5x1.5	1.54	1.54	8,470	.210	..
1007	2x2	2.01	2.04	15,890	.240	..
1008	2.5x2.5	2.52	2.55	39,650	.200	..
1009	3x3	3.04	3.03	51,400	.180	..
1010	3.5x3.5	3.51	3.59	103,460	.160	.13
1011	4x4	4.10	4.15	168,640	.140	.11

TABLE NO. 6.

Series E.

TRANSVERSE TEST.

Sand Roll Iron—Bars in Dry Sand and Not Machined.

No.	Approx. Cross Section. Ins.	Actual Size. Depth. Ins.	Actual Size. Width. Ins.	Breaking Strain. Lbs.	Deflection. Ins.	Contraction. Ins.
1012	0.5x0.5	0.50	0.54	410	.250	.23
1013	1x1	1.00	1.00	2,450	.220	.18
1014	1x1	1.00	1.00	2,460	.230	..
1015	1.5x1.5	1.48	1.50	8,710	.210	.17
1016	1.5x1.5	1.48	1.50	8,200	.200	..
1017	2x2	2.00	1.98	12,930	.230	.16
1018	2x2	1.96	1.98	16,000	.220	..
1019	2.5x2.5	2.44	2.50	38,400	.190	.15
1020	2.5x2.5	2.50	2.50	39,200	.180	..
1021*	3x3	2.94	2.94	50,500	.170	.14
1022	3x3	3.00	2.98	53,300	.170	..
1023*	3.5x3.5	3.46	3.50	91,200	.160	.13
1024	4x4	4.10	3.88	140,540	.170	11

*Slight flaw.

TABLE NO. 7.

Series E.

TRANSVERSE TEST.

Sand Roll Iron—Bars in Green Sand and Not Machined.

No.	Approx. Diameter. Ins.	Actual Size. Depth (d) Ins.	Actual Size. Width (d) Ins.	Breaking Strain. Lbs.	Deflection. Ins.	Contraction. Ins.
1025	0.56	0.56	0.58	480	.280	..
1026	1.13	1.10	1.13	2,310	.215	.17
1027	1.69	1.74	1.73	7,100	.180	..
1028	2.15	2.24	2.23	20,650	.190	.16
1029	2.82	2.92	2.94	44,200	.180	.15
1030	3.38	3.32	3.20	61,800	.190	.14
1031	3.95	3.94	3.90	99,280	.180	.13
1032	4.51	4.30	4.36	128,980	.150	.12

TABLE NO. 8.

Series E.

TRANSVERSE TEST.

Sand Roll Iron—Bars in Dry Sand and Not Machined.

No.	Approx. Diameter. Ins.	Actual Size. Depth (d) Ins.	Actual Size. Width (d) Ins.	Breaking Strain. Lbs.	Deflection. Ins.	Contraction. Ins.
1033	0.56	0.53	0.54	400	.240	..
1034	1.13	1.14	1.15	2,330	.210	.18
1035	1.13	1.10	1.13	2,230	.200	..
1036	1.69	1.67	1.68	6,120	.200	.16
1037	1.69	1.69	1.69	6,950	.190	..
1038	2.15	2.20	2.21	19,340	.180	.15
1039	2.15	2.25	2.18	24,000	.190	..
1040	2.15	2.26	2.20	19,860	.170	..
1041	2.82	2.73	2.75	38,000	.180	.14
1042	2.82	2.78	2.77	40,500	.175	..
1043	3.38	3.38	3.30	64,100	.200	.13
1044	3.38	3.38	3.32	70,000	.210	..
1045	3.95	3.94	3.94	93,840	.180	.12
1046	4.51	4.50	4.52	169,340	.170	.11
1047	4.51	4.48	4.47	158,500	.180	..

APPENDIX TO ACCOMPANY THE PAPER OF THE COMMITTEE ON THE STANDARDIZING BUREAU OF THE ASSOCIATION.

At the convention, Cincinnati, June, 1898, a committee was appointed for the purpose of establishing a central agency for the distribution of standardized drillings. This committee found its origin through the interest of the Pittsburg Foundrymen's Association in a paper, by Thos. D. West, showing the need of greater uniformity in analyses, and suggesting, in outline, plans for orginating a central standardizing agency, read before that body April 25, 1898, and published in the American Foundrymen's Association Journal of May, 1898. It was a reform of which but few realized the importance and the obstacles to be overcome before the same could be established.

Almost every trade possesses some means by which its artisans can tell whether their labors have been productive in

obtaining the perfection desired. The appearance of the finished casting indicates to the furnaceman or founder the results obtained from his iron. A trial of a machine or engine shows the machinist or engineer the perfection he has attained, but the completion of an analysis by a chemist presents no tangible evidence of the accuracy of his results. The only way a chemist can know the correctness of his results or give others assurance that his work is right is by having them checked or by analyzing drillings that have been determined by competing chemists, to find whether results agree. The latter process is, in a sense, a method of checking similar to the use of standard weights to test the accuracy of scales. No laboratory is complete without its standards any more than a furnace or foundry would be without standard weights for occasional test of scales.

In brief, standardized drillings are especially prepared and carefully analyzed samples of iron, by which the chemist can test the accuracy of his work.

The necessity for a laboratory having something in the way of standardized drillings has led many heretofore to make their own. This has generally been done after the following plan: The chemist, having decided upon the grade of iron thought best for the work, sought out a piece of clean pig metal of such grade, and drilled it until he had obtained from eight to twelve pounds of drillings. These would be well mixed and, in some cases ground in a mortar to make them sufficiently fine to pass through a ten, twenty or forty-mesh sieve. This done, he would put up packages of a few ounces each and mail them to other chemists with a request that they analyze them for metalloids for which he wished to obtain standards. When the different results had been reported, he would accept the average as his standard for the drillings in his possession, and which were generally preserved by tightly sealing in a bottle, labeled with the analysis, and kept on hand for use at any time.

These standardized drillings, being accepted as containing certain percentages of carbon, silicon, sulphur, manganese or phosphorus, could be reanalyzed at any time to check the

chemist's own or others' work. An observing person, having an opportunity to visit laboratories, could often find the chemist using these standards to check chemical, or some short-cut method which he or some other chemist had devised. Then again, they might be used as checks when the correctness of results had been questioned. In reanalyzing a standard, should a different result be obtained, the chemist was naturally left to conclude that some of his chemicals, methods or work was at fault.

The process by which the individual chemists obtained their own standards was, as a rule, long and tedious. It often took from four to six months to get in all the results. Then again, as a rule, the results varied so much that the average accepted would at times seem more like guess work than anything coming from accurate work and methods, a fair example of which results are seen in Table 1, page 2. The variation in analyses thus obtained have often caused great differences in standards in use in different circles and perplex managers of furnaces, steel works, foundries and chemists, rather than help to correct evils and prevent losses.

It was the opportunity of observing the practice of blast furnace chemists in obtaining their standards which led Mr. West to conceive the idea of originating one central agency from which all could obtain standardized drillings which had been determined by a few of our best known chemists.

The first work of our committee was to adopt and perfect plans to achieve the end sought. This was done practically upon the lines suggested in the paper by Thos. D. West read before the Pittsburg Foundrymen's Association, April, 1898, and which secured for us the able services of Prof. C. H. Benjamin to supervise the work of making drillings from cylindrical castings, and that of Prof. A. W. Smith (both of Case School of Applied Science) to carry forward the work of preparing, standardizing and packing the samples. We were also fortunate to secure and combine the services of Messrs. Booth, Garrett & Blair, Andrew S. McCreath, Cremer & Bicknell and Prof. A. W. Smith to

XUM

analyze the drillings, the average of which results were accepted as standards.

The greatest obstacle in the way of establishing and maintaining a central standardizing agency lay in the difficulty of obtaining a sufficient amount of uniform turnings or drillings from one sample of iron, free of sand, grit, slag, etc., to permit all laboratories to obtain a pound or more of them. As a rule, chemists have found it difficult to obtain 25 pounds of clean, uniform and reliable samples.

A study of this phase of the subject will show that the practicability of establishing and maintaining a central standardizing bureau is largely dependent upon the ability of the founder to make large castings, weighing 500 pounds or more, from which could be obtained a large amount of clean, uniform drillings. For this reason a well-known writer has aptly said that the establishing and maintaining of a central standardizing agency is properly foundrymen's work. As the making of these castings involves principles of founding interesting to many, we illustrate the plan used, which is as follows: A mold of dry sand for the outer body and a dried core for the inner are made as seen in the plan and section view of Figs. 1 and 3. The construction of the mold explains itself. The secret of getting a clean, solid casting lies mainly in the method of gating and pouring it. At A is a gate leading down to the bottom of the mold at an inlet at D. The round gates B, seen at the top of the mold, are placed about 4 inches apart and are $\frac{1}{2}$ inch diameter. A riser is seen at E. In starting to pour the mold the molten metal is directed to drop from the ladle into the basin at the point marked W in a way that will allow it to flow gently down the gate A and enter the mold at D to prevent the bottom being cut by the top gates. When from 30 to 50 pounds of metal has entered the mold, a quick turn of the ladle empties a large body of the metal into the pouring basin, quickly filling all the gates at B; this then drops the metal down upon that which is rising from the stream flowing in at D. This action is kept up until the mold is filled and the metal runs out at the

riser E. After this point is attained, the pouring is slackened and a steady stream maintained until from 300 to 500 pounds of metal has flown through the riser E to run down the incline seen at S into the scrap hole X. The effect of allowing such a large body of metal to flow through the mold by making it enter the gate at A is to keep up an agitation after the mold has been filled, which in turn will be most beneficial in causing

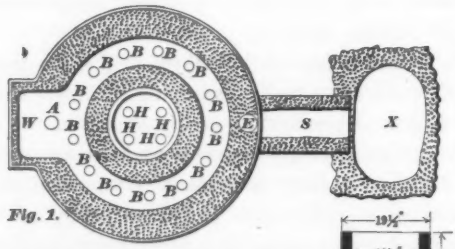

Fig. 1.

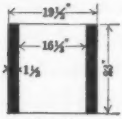

Fig. 2.

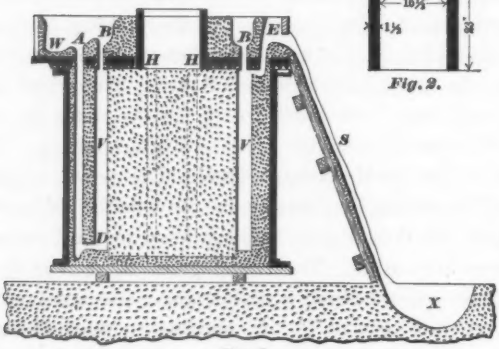

Fig. 3.

the metal in the mold to mix well and counteract variations in structure that might otherwise take place. The metal dropping from the top gates B causes a disintegrating action, cutting into a fine dust any dirt that might accumulate upon the surface of the rising metal, and which, were it not thus chopped up, as it were, into fine particles, would gather in large lumps, and be caught and held fast in the mold walls, with the result that dirt spots, etc., would be found in the casting when the skin was re-

moved by a drill, lathe or planer. Again, the fact that the metal drops from the top of the mold besides entering at the bottom, causes the top body of the rising metal to be as fluid as that at the bottom, which is also beneficial in causing all scum and dirt to float upward with the metal to the top of the mold or "riser head." Where metal fills a mold all from the bottom, it becomes rapidly duller in rising to fill the mold, an evil which will be readily seen.

Fig. 2 shows a section of the casting obtained from the mold, with the exception of four lugs cast on to assist in holding the cylinder or casting in the lathe while it is being turned. It is to be remembered that these castings had not only to be perfectly clean and sound, but that they had to differ in containing certain percentages of silicon, sulphur, phosphorus and manganese. Some difficulty was experienced and time lost in securing irons that would give the different percentages of metalloids desired in the casting. Then again, when these metals were obtained, special provision had to be made to melt them properly, which was done very satisfactorily by a little cupola being fitted up especially for the work.

It will be well, at this point, to state also that there is no difficulty in obtaining castings running into tons which might serve for standardizing purposes, if cast upon the principles herein described.

Before starting to make these castings, investigations were made as to the variations in metalloids most likely to be demanded by the trade in general. It was found that samples, high, medium and low in silicon, sulphur, manganese and phosphorus would satisfy most of our country's laboratories as far as iron standards were concerned. To obtain this variety of standards called for the making of three distinct castings of different grades of iron. These were cast at the Thos. D. West Foundry Co., upon the plan herein described and proved excellent for the work intended.

To obtain the turnings or drillings, which had to be fine enough to pass a 20-mesh sieve, was no easy matter and rather

a costly affair. To get one pound of drillings per hour was thought to be good work.

The plan of securing these turnings or drillings was first to take off about $\frac{1}{8}''$ from the surface of the casting. These first turnings were cast aside, as they contained more or less scale and dirt formed on the surface of the casting by the fusing action of the molten metal upon the sand forming the face of the mold. After this surface has been turned off, and all debris removed carefully from the lathe, the cylinder is turned until about $\frac{1}{4}''$ thickness of the inner shell remains. The turnings obtained from the body after the $\frac{1}{8}''$ thickness is removed from the surface are the ones taken for standardizing purposes. It should be stated that about $\frac{1}{2}''$ thickness at the bottom and the "riser head" of two inches at the top are not disturbed, so as not to have the scale on the bottom of the casting or any dirt that would be collected at the top end mixed with the turnings obtained from the inner body of the casting.

After the turnings had been thus obtained, they were passed through a 20 and 40-mesh sieve. This done, the drillings were then spread out on a large carbonized cloth and thoroughly mixed. The mixing having been perfected, bottles, holding one-third pound, were placed in convenient position and filled with the drillings by having a scoop holding sufficient drillings to give each bottle an equal portion from every filling of the scoop. In filling the scoop drillings are taken from different parts of the spread so that all bottles will contain some of every portion of the drillings. Repeated analyses of different bottles have proved the mixing to be all that could be desired. These bottles were packed in paper cases made expressly for the work. There are two sizes of cases, one holding three bottles, or one pound of drillings, the other holding four bottles, or one and one-third pounds of drillings. To allow all a chance to observe the form and manner of packing these drillings and the character of their finish, as being distributed to the trade, an illustration is given herewith.

The standardized samples on hand cover the following determinations:

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Silicon, one each of a low, medium and high range of cast iron.

Sulphur, one each of a low, medium and high range of cast iron.

Manganese, one each of a low, medium and high range of cast iron.

Phosphorus, one each of a low, medium and high range of cast iron.

Total carbon, one determination.

Graphite, one determination.

Titanium, three determinations.

In all, 17 determinations made on four (4) samples.

The samples are designated as A, B, C and D. Sample A, which has been ground to pass a 40-mesh sieve, gives one total carbon and one graphite. Sample B gives a low silicon, a medium sulphur, a low manganese, a phosphorus which is within the Bessemer limit, and a titanium. This has been passed through a 20-mesh sieve. Sample C gives a medium silicon, high sulphur, medium manganese, medium phosphorus and a titanium. This has also passed a 20-mesh sieve. Sample D gives a high silicon, low sulphur, high manganese, high phosphorus, and a titanium, and has passed through a 40-mesh sieve.

The standards are sold at the price of $5.00 per pound (a discount of 40 per cent is allowed to colleges), and in no instance will less than one pound be sold. The samples are packed in bottles, holding one-third of a pound and delivered in cases, as illustrated on page 8, holding three or four bottles according to the desires of a subscriber. One bottle each of samples A, B, C and D can be had, or a subscriber can have three or four bottles of all one sample, or two or three bottles of one sample and one of another; in fact, bottles of samples B, C and D can be sent in any proportion desired, as it is the wish of the committee to follow the desires of all purchasers, as far as it is in their power. One pound of the samples should furnish enough material for 36 complete analyses, or at least 200 separate determinations. The exact analyses of the samples A, B, C and

D will be sent separately by mail, so that they may be placed upon bottles or kept private, as desired by the subscriber.

By addressing any member of the following committee all orders for drillings will receive prompt attention. Money can accompany orders or be sent after receipt of drillings as may best suit the pleasure of the buyer.

The amount asked for these standards, considering their cost, is very low, and the drillings such that no chemist could manufacture them for himself at many times the price. The outlay for preparing the four samples was somewhat over $450.00. Moreover, the good that subscribers can accomplish in assisting to promote greater uniformity in the work of laboratories, which have to deal with cast iron, is such that no matter to what part of the country any portion of the sample may be sent, like reports of analyses can be expected at the hands of careful chemists, who are only too often compelled to resort to short-cut methods in order to keep up with the work of their laboratories.

THOS. D. WEST, Sharpsville, Pa.
RICHARD MOLDENKE, Pittsburg, Pa.
JAMES SCOTT, Pittsburg, Pa.
P. W. GATES, Chicago, Ill.
E. H. PUTNAM, Moline, Ill.

The following are the names of laboratories using the Association's standards in May, 1900:

Bellefonte Furnace Co.
Lebanon Furnaces.
Isabella Furnace.
Virginia Iron, Coal and Coke Co.
Canada Iron Furnace Co., Radnor Forges.
Canada Iron Furnace Co., Midland.
Dunbar Furnace Co.
Danville Bessemer Co.
Minerva Pig Iron Co.
Jefferson Iron Co.
Emporium Furnace Co.
River Furnace & Dock Co.
Iron Gate Furnace.
Missouri Furnace Co.
Ashland Coal, Iron & R. R. Co.
Pickands, Mather & Co.
Monongahela Furnaces.

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M. A. Hanna & Co.
Sharpsville Furnace Co.
Spearman Iron Co.
Mabel Furnace Co.
Stewart Iron Co.
Brier Hill Iron & Coal Co.
Andrew Brothers Co.
Girard Iron Co.
Longdale Iron Co.
Everett Furnace Co.
Warwick Iron Co.
Embreville Iron Co.
Tennessee Coal, Iron & Railway Co.
Hamilton Blast Furnace Co.
R. Heckscher & Sons.
Dora Furnace Co.
McNair & DeCamp Co.
Allegheny Iron Co.
Northwestern Iron Co.
Iroquois Iron Co.
Tonawanda Iron & Steel Co.
Elk Rapids Iron Co.
Ohio Iron & Steel Co.
Penn Iron & Coal Co.
Thomas Iron Co.
New River Mineral Co.
Emma Furnace.
Colonial Iron Co.
Lackawanna Iron & Steel Co.
Empire Steel & Iron Co.
Union Iron & Steel Co.
Buffalo Iron Co.
Alabama Consolidated Coal & Iron Co.
Chickies Iron Co.
Logan Iron Manufacturing Co.
Carbon Steel Co.

E. & G. Brooks Iron Co.
Chicago, Burlington & Quincy R. R.
Noyes Bros., Sydney, Melbourne, Australia.
Salem Iron Co.
Hecla Works, Sheffield, England.
Woodward Iron Co.
Union Iron Works, San Francisco.
Pioneer Mining & Manufacturing Co.
Carbon Iron & Steel Co.
Franklin Iron Works.
Camden Iron Works.
Carteret Steel Co.
Nova Scotia Steel Co.
Deutsche Niles-Werzeugmasschinen-Fabrik.
Schickle, Harrison & Howard Iron Co.
Andover Iron Co.
Illinois Steel Co.
Kittanning Iron & Steel Co.
Sharon Iron Works.
Youngstown Steel Co.
Bethlehem Iron Co.
Pensylvania Steel Co.
Ashland Steel Co.
Carnegie Steel Co.
Clinton Iron & Steel Co.
Sloss Iron & Steel Co.
Atlanta Iron & Steel Co.
Watt Iron & Steel Co.
Reading Iron Co.
Marting Iron & Steel Co.
U. S. Cast Iron Pipe & Foundry Co., Anniston, Ala.
U. S. Cast Iron Pipe & Foundry Co., Bessemer, Ala.
U. S. Cast Iron Pipe & Foundry Co., Addyston, Ohio.
Farrell Foundry & Machine Co.
Missouri Malleable Iron Co.
The Bell City Malleable Iron Co.

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Pennsylvania Malleable Co.
Oil City Boiler Works.
Union Car Co.
N. Y. Air Brake Co.
James Clow & Son.
Builders' Iron Foundry Co.
Snow Steam Pump Co.
William Cramp & Sons.
Frank-Kneeland Machine Co.
Pittsburg Locomotive & Car Works.
McConway & Torley Co.
J. I. Case T. M. Co.
Syracuse Chilled Plow Co.
Gates Iron Works.
Sargent Co.
Draper Co.
The Thos. D. West Foundry Co.
Eimer & Amend, Importers, 4 laboratories.
O. Sowers.
William M. Strong.
Charles F. McKenna.
Lucius P. Brown.
Rome Testing Laboratory.
Walter M. Sanders.
Enrique Tonseda.
Durant Woodman.
C. E. Linebarger.
R. C. Hindley.
Ludw. Loewe & Co., Berlin.
Edward J. Wheeler.
William J. McGavok.
Dickman & McKenzie.
F. A. Emmerton.
Mariner Hoskins.
J. Blodget Britton & Co.
Stevens Institute of Technology.

Boulder University.
Niagara University.
Cooper's Union.
Virginia Polytechnical Institute.
University of Buffalo.
Purdue University.
Harvard College.
Wooster Polytechnical Institute.
Lehigh University.
Columbia University.
University of Pennsylvania.
University of Michigan.
Massachusetts Institute of Technology.
Ohio State University.
Yale University.
Michigan School of Mines.
Havemyer University.
Webster University.
University of Minnesota.
Fort Wayne High School Laboratory.

An encouraging part of this work is the appreciation many exhibit of the advance the American Foundrymen's Association has made in establishing a central bureau for the distribution of standardized drillings, as may be seen by letters here on file for your inspection and from which testimonials we quote the following extracts:

"Your plan to systematize this useful work and to carry it out on a larger scale appeals strongly to me, and it is to be hoped that the outcome may be fruitful in benefit both to the makers and to the users of iron.

THEODORE WM. RICHARDS,
Chemical Laboratory of Harvard College."

"Permit me to express my belief that this work of your association of distributing carefully analyzed samples of pig iron is of great value to the metallurgists and chemists of this country.

H. L. MILLS,
Professor Analytical Chemistry,
Sheffield Scientific School of Yale University."

XUM

"I believe that every technical school should have a full line of your samples always in stock.

N. W. LORD,
Professor of Metallurgy and Mineralogy,
Ohio State University."

"I have noticed with pleasure your praiseworthy efforts to establish uniformity in pig iron analysis. * * * Thanking you for your endeavors to mitigate the perplexities of both the furnace manager and the chemist,

JOHN P. MARSHALL,
Supt. Missouri Furnace, Carondelet."

"I think the method of selling standardized iron samples from a central laboratory, such as the Standardizing Bureau of the American Foundrymen's Association, is one to be commended. The confidence I have in my work after checking with these drillings is very gratifying.

WALTER M. SAUNDERS,
Analytical and Consulting Chemist,
Providence, R. I."

"Yours of the 27th inst. received, and having been referred to our chemist and engineer of tests, he makes the following report: 'In reference to the A. F. A. standards, would say I am pleased with them and take pleasure in indorsing them.'

WILSON MILLER,
President Pittsburg Loco. & Car Wks.,
Pittsburg, Pa."

"We take pleasure in this opportunity to give you a word of encouragement. Trusting you will be successful in interesting all users and makers of pig iron.

R. HECKSCHER & SONS,
Swedeland, Pa."

"We take pleasure in saying that our chemist states he has used the standardized drillings in standardizing solutions and found them to be very exact; and adds that too much praise cannot be accorded the standardized drillings you recently sent us.

ELK RAPIDS IRON CO.,
H. B. Lewis, Pres."

"It is no little comfort to have the standardized samples and to know that the work of our laboratory is correct and reliable.

EDGAR S. COOK,
Pres. Warwick Iron Co., Pottstown, Pa."

"We are pleased with samples. They will, without doubt, greatly promote increasing accuracy in methods of iron analyses.

J. BLODGET BRITTON CO.,
Warrentown, Va."

"We are using standardized drillings for standardizing solutions of sulphur and phosphorus, also for checking other determinations of silicon, graphite, carbon and manganese, and find them very useful in our laboratory. We think it very necessary that laboratories should be supplied with standardized drillings, especially those working on blast furnace products.

L. C. PHIPPS,
Second Vice-President Carnegie Steel Co., Pittsburg, Pa."

"We are entirely in sympathy with the efforts of your committee, which has our heartiest commendation. * * * We fully appreciate the value of the results which are sure to follow your work, and are very glad to avail ourselves thereof.

J. C. DAVIS,
Supt. The Sargent Co., Chicago, Ill."

"The thanks of all users of iron and employers of chemists are due your committee.

FRANK-KNEELAND MACHINE CO.,
Isaac W. Frank, Pres. and Genl. Mngr."

"The standard samples are a grand idea and the confidence they impart is worth ten times the cost. W. G. SCOTT."

"We do not see how any firm can afford to do without them as they are worth many times their cost.

SYRACUSE CHILLED PLOW CO.,
W. W. Wiard, Asst. Sec."

"We are in hearty sympathy with the objects of the committee, and believe that only good will result to manufacturer and consumer alike. FRANK TENNEY,
Asst. Supt. Penn. Steel Co., Steelton, Pa."

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"It is the greatest move for improvement in many years.
ERASTUS C. WHEELER."

"We have checked our routine laboratory work from time to time since receipt of drillings and have found them to be of inestimable value to us.
KITTANING IRON & STEEL MNFG. CO.,
W. L. Scott, Chemist."

"The opportunity which your association offers to obtain in quantity uniform iron samples of definite character, and with statements of the results obtained by experienced analysts must, I am sure, be welcome to every teacher.
H. P. TALCOTT,
Mass. Institute of Technology."

"In connection with the use of the standardized drillings, I wish to say that I believe the plan will result in attaining greater accuracy, will inspire confidence and will enhance the value of analytical chemical work in connection with foundry practice.
W. P. RICKELLS,
Columbia University."

"I am in most hearty accord with the aims and purposes of the American Foundrymen's Association, and believe its aims worthy of support and confidence.
PROF. EDGAR F. SMITH,
Director Laboratory, University of Pennsylvania."

"I very cheerfully say that your idea of having standardized drillings through which to secure greater accuracy from furnace chemists everywhere is entirely admirable.
J. R. JOHNSON, Mngr.,
Longdale Iron Co."

"It has always been a task to get standards, especially standards that would check up with those from different concerns. It will simplify matters considerably if chemists will use standards from one party of the same value, as I have found that most of the errors in sulphur and phosphorus come from different chemist's standards not checking.
J. O. MATHERSON, Chemist,
Ashland Coal Iron & Railway Co."

THE PROBLEM OF MACHINE MOLDING.

BY MR. E. H. MUMFORD, ELIZABETH, N. J.

The much discussed question, how molding machines shall be used in our foundries and the reasons why there should be any discussion of the question whatever, are made the subject of what is written below.

It may be well to look at the real hard facts in the situation as the machine finds it to-day; try to find reasons for these facts and then to discuss the future of the molding machine from the basis of the present and the deductions it is possible to draw.

There are five prominent facts:

1. Molding machines have entered upon a field of work in which they have proved their usefulness and economy, and in which they are destined to remain instruments of progress.

2. Machines dispense with some of the skill necessary to the molder by the method of their working and render more of this skill unnecessary by avoiding some of the difficulties hand molding introduces, such as mending broken corners, etc. They may, therefore, be successfully worked by unskilled laborers.

3. While laborers are perfectly well able to make machines profitable, in doing this they generally earn almost molders' wages, when paid by the piece or when putting up a large day's work, and it is therefore possible for a molder to do as well for the owner of the machine and for himself as the laborer does if he will work as hard.

4. The molder will not do as large a day's work as the laborer on a molding machine for the same amount of money, and is therefore an expense to the owner of the machine he runs, similar to what would result if molders were to charge the cupola or run the cranes.

5. There is work enough for both machine and molder and the machine, taking, as it does, the repetition work, relieves him of the monotony which the general introduction of machines

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is accused of forcing on the wage earning class as a whole, and owing to the speed and cheapness with which the machine turns out small parts, more of the larger and more intricate portions of machines are called for from the molder.

Another fact that is proven by statistics is that the general introduction of labor saving machinery in the world of manufacture, while it has undoubtedly the (at least temporary) effect of displacing labor in the special field which it enters, yet increases rapidly the number employed in two other fields, namely: that where the machines are built and that which uses no machinery at all. That is, anything which facilitates the use of labor saving machinery in general, as in the textile and agricultural industries—which the molding machine obviously does, increases the number of men employed in making these machines. As the molder, most naturally, is interested in the future of his trade, he should, therefore, do everything he can to encourage machine building in general, and nothing offers a better opportunity than leaving the molding machine absolutely untrammeled in its natural progress with unskilled labor.

To say that molding machines have found and entered upon their field of usefulness rather under than over states the fact. They have partly created the field. This will be understood to be particularly true when it is considered that everything may be treated as a molding machine which substitues a mechanical guide or movement completely for an action of a molder, thus taking over for the special case, perhaps, this action to itself. A simple illustration of a molding machine of this sort, if it had enough parts to be called a machine, would be the time honored match or follow board. This simple machine element usurps completely the very tedious and delicate operation of jointing the surface of the drag around the pattern. There is absolutely nothing of this operation left for the molder when the match board is lifted off, if it has been properly fitted to the pattern, and, add to the board a hinge and clamp so that it rolls over with the drag, or provide it with mechanism for its removal, as a crane, and, in the combination, you have a molding machine which simply joints the mold.

It is safe to say that, if every pattern had had to be jointed in a mold by hand for all the years since match boards first came into use, relatively very few duplicate castings or machines embodying them would be in use to-day. The match board, the sand match, the hand rammed stripping plate, the power rammed stripping plate, with automatic draft, the vibrator machine with patterns and match in one piece, the vibrator frame using patterns without expense for fitting to the molding machine, and thus rendering the most irregular patterns instantly applicable to molding machines, are all steps of progress in the creation and development of the machine molding field.

In other words, the molding machine is not a new thing introducing new problems and conditions to the trade. By the perfectly natural and irresistible evolution of its destiny it has finally reached a point of independence where it does not need the expense of the skilled craftsman.

Simultaneouly with it, has come the greatly extended use of duplicate castings, the demand for which the molding machine has helped to create, so that it comes not as a beggar but as a useful and well known member of society.

The officers of the Iron Molders' Union have recently taken the stand that, to quote their own words, members of the Union should be allowed "to develop the best possibilities" of the molding machine, thus also to "control" the machine. Undoubtedly these men are perfectly sincere in their belief that these things can be done and some attempts to prove this have been made. Now the "best possibilities of the machine" are of course those in the path of economy in its use and the demonstrations of the molder's power in this direction have not been such as should encourage him to persevere.

Some machines of the most efficient modern type were undertaken by Union molders in a line of work where it was, by chance, perfectly easy for the writer to make exact comparison with exactly similar machines on exactly the same work in another shop. Result: 65 flasks from the molder for $2.75, and 160 flasks from the laborer for $2.40—i. e., what was costing more than 4c in one shop was costing only 1½c in the competing shop, and I have wondered ever since if the Union seriously

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meant this as an initial step toward the "control" of the molding machine, as it certainly could not be considered their "best possibilities." No, the control of the molding machine will never pass from the hands of the evolutionary destiny of the manufacturing world to either the molder, the builder of the molding machine or its owner. And the figures quoted above show that machines may be made to pay without molders.

Why the molder will not work harder, so as to make the molding machine as successful in his hands as in the laborer's, is not a hard question to answer. Very little use for his hard learned trade is called for. If the molder would succeed as a machine operator, he must forswear his handicraft and strengthen his back, and there is, as he wisely reflects, no real reason why he should—therefore he doesn't. Why should he?

But why does the Molders' Union seek to control the machine? It has been implied by one of its officers that it is because it is becoming a power which threatens the power of the organization. This is true of some shops absolutely, of some partially, and in some, as the machine is known to-day, it never will be true, and nothing except the development of the machine and its accessories can change the situation.

In the first instance, the entire work of the foundry is or will be molded by machines; in the second, the machines mold or will mold a portion of the work, and in the third, the work is of such a sort that no existing machine can profitably handle it. In the first named foundry, no molders will be found of the kind we are discussing. In the second, molders will be found making such pieces as the machines would pay on, and making more of those very pieces because the machines have cheapened the smaller castings, making it easier to get what probably represents the more troublesome and expensive parts of some line of manufacture, and to get them so promptly that more of the large pieces are sure to be needed on account of improved deliveries of the finished outfit. There is thus, apparently, every reason why the molding machine, with its unskilled labor, and the molder, should form a very happy working family in such a shop, and why they do not is hard to see except there is being forced there some ulterior object foreign to the interests of the molders in that shop and foreign to the interests of the shop owner.

The only possible reason why, in a shop employing both molders and molding machines operated by unskilled labor, the Molders' Union should object to such operation of the machines seems to be this: In case of a difference of opinion between the Union and the owners of the foundry as to how (the owner would say) the shop should be run or (the Molders' Union would say) the men should be treated, which involved a strike, the foundry would not be absolutely closed, inasmuch as the machines would not be stopped, and heats would be taken off every day.

If this is the reason why the Molders' Union is seeking to "control" the molding machine, then what has been written above has no interest for the molder, there need be no pretense of an attempt to "develop the best possibilities of the machine" nor argument of the present nor thought of the future. Everything is plain and above board, as soon as this is admitted, and "control" of the traveling crane, or the water supply, or the highway leading to the foundry, would do as well.

I will not think that anyone interested in the future of the iron or brass molders' trade will do anything to impede the progress of the molding machine. I do not think even, that any employer will be deterred from introducing improved machinery such as molding machines in his foundry by any consideration except the economy he may realize from its use with unskilled labor, and I know that the introduction of the molding machine in our foundries is as certain to be successful as that of the turret lathes (to which the molding machine has often been likened) and the other automatic machines all through the machine shop.

I would close by saying that, as a builder of molding machines, I know the situation to be as I have pictured it above, and what I have written is not mere theory of a machine molding millenium, but the sober judgment of experience.

Let me further say that, in mingling with molders who have worked for me and dealing with their Union Committees, I have found them, individually, men of such good sense and spirit that I have built upon these qualities among the molders the expectation that the present rather absurd obstruction of the molding machine operated by men not molders, but men for all that, will speedily die out.

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ELECTRIC TRAVELING CRANES.

BY MR. A. D. WILLIAMS,
Shoenberger Steel Mills, Pittsburgh, Pa.

In nearly all foundries cranes are employed to do heavy lifting, and the overhead traveller, in most cases using electric power, has become a very desirable part of foundry equipment. The idea in this paper is to consider the multimotor electric crane from the user's standpoint, taking up its desirable and undesirable features, without attempting to give a detail treatise on crane designing. The only machines that never break down are those which are never used. Cranes are no exception to this rule, and the natural depravity of inanimate objects always causes the selection of such a time as will result in the greatest possible inconvenience to all concerned. Many serious crane accidents have occurred and some of these are no doubt fresh in the memory of Pittsburgh foundry men.

The slings used in handling loads are really not part of the crane, but they are a source of trouble. Chain slings are the best, they are flexible, do not chafe, and damage to finished surfaces can easily be prevented by a little care in using. Their periodical inspection is necessary, and they should be annealed from time to time. Rope slings are liable to cut and are uncertain. In many places their use has been stopped, after an accident has cost more than a good set of chain slings.

For hoisting purposes chain is most commonly used on account of its flexibility, this means smaller drums and sheaves, and a higher hoist than can be obtained on the same crane with wire rope. Only the best grade of tested chain should be used. As this becomes fatigued by long use, small cracks may develop. Its durability of course depends on the service the crane gets, and defects are not easily detected. Chains should be kept well lubricated, and annealed occasionally. Where wire rope is used its condition is readily seen, no expert being required. In this respect it is safer than chain. Extra flexible wire rope is manufactured which is well adapted to crane service on account of the moderate size of the sheaves and drum required. It is not an experiment for hoisting purposes, but its use on electric cranes is

not as common as it would be if its good qualities were thoroughly appreciated.

Hooks are made of various materials, forgings of wrought iron and steel are used in many cases, but malleable iron and steel castings are also employed. Malleable castings are only used for very light sections. For heavy work forged hooks are universally employed, and cast steel hooks have been used for medium size cranes. A first-class steel casting is much better than a poor forging, though the material to be specified is largely a matter of individual preferences. With proportions suited to the metal, it makes very little difference what is used, the chances of flaws are about even, and a burnt forging is not any more reliable than a defective casting.

Some cranes are so constructed that in hoisting and lowering the load is twisted more or less around a vertical axis, this necessitates extra care in its guidance. This style of hoist is not well suited for foundry purposes, as the attempt to correct this twisting can be very easily overdone with disastrous results. For the foundry a vertical hoist without any twist in it fits the bill best, and for almost all purposes is the most desirable.

The electric motors, controllers and wiring on cranes should all be arranged and constructed so that repairs can be easily and quickly made. Perfect insulation is impossible, as all substances conduct electricity more or less. There are a number of grades of insulated wire, and a good quality run on porcelain insulators or in moulding arranged so that no two wires can come in contact with each other or with any metal should be insisted upon. Nearly all the electrical troubles with cranes arise from imperfect insulation. No detail is too small to be slighted in this respect, as fine dust and "flyings" are liable to settle anywhere, and a ground or short circuit from this cause may be expensive. Wooden battens should be used to prevent the trolley from swinging against the girders, but wood alone should never be depended upon as an insulator.

Crane controllers are important, as the entire manipulation of the machine depends upon them, this like the clutch of the mechanically operated crane is a weak point. The practically perfect crane controller is yet a matter of the future. All parts should be accessible, and so arranged that those subject to wear can be removed and replaced with a minimum amount of trouble.

The resistance coils should be arranged so that close control over the crane can be obtained, as without it delicate handling is impossible. The device by which the operating levers are centered, or held in the position at which the current is off, should be so positive that the operator is not likely to throw the lever too far and reverse unintentionally. Any weakness in this device is a constant source of danger, yet it is desirable to have easy working controllers.

The electric motors used should be enclosed in dust proof casings; those built for crane service by the large electrical concerns are very compact and accessible, their designers have had the benefit of wide experience gained in street railroad work, and the motors they produce give very little trouble. Standardization of all parts has been followed out, so that repairs are in most cases very simple, and extra parts can be carried in stock. Special motors are things to be avoided, a bill for repairs would furnish sufficient explanation. The armature and commutator of a motor are its two most vulnerable parts, and it is much easier to remove them when attention is required than to attempt their repair in place. In most cases removal is absolutely necessary. A set of spare armatures adds to the cost of a crane, but it will save a delay at an inopportune time, as slight faults can be corrected which, if given time to develop, would prove expensive.

Crane brakes or safety devices are of two kinds, one which acts upon the interruption of the electric circuit for any cause, the other operated by the load. The former is generally called the magnetic brake, because it is thrown out of action by magnetism, being thrown on by a spring or by gravity. The force of gravity is not very likely to fail, springs are not so reliable. The braking effect is obtained by a cast iron drum keyed to one of the shafts (preferably the armature shaft) where its effect will be greatest, and a brake strap acting on the drum. This strap is often made of sheet steel and its friction surface fitted with a renewable lining of wood, leather, or other suitable material. Naturally this brake strap requires adjustment from time to time to take up the wear. This brake is made single or double acting, its principal duty is to overcome the inertia of the armature and to stop the load promptly. It should, however, be of sufficient size to hold the load. The designing of one of these brakes presents some interesting problems. Too little of it is only an aggravation, and

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when too large it is troublesome and may twist a shaft in two by stopping one end before the other. A modification of the Weston disk brake has also been successfully used as a magnetic brake.

The load brake, variously called the automatic brake, safety retaining clutch, mechanical brake, etc., is made in a number of designs by different makers, the basic principal is the same in all. The tendency of the load to run down acts to set the brake, which is arranged to permit hoisting freely. In lowering the motor acts against the tendency of the load to lock the brake, and the load cannot move until these two forces balance each other; the brake absorbs the acceleration of gravity on the load so that it can only drop at a speed proportional to that of the motor. It might be said that the motor has to push the load down, this does not describe the action accurately, but it is close to it. It is highly important that the operation of this device should be smooth, any irregularities in its action causes the load to descend in a jerky fashion, which means excessive strains in the whole structure, and tends to develop defects. While no apparently serious results may appear at the time, there is the ever present risk that some part may have been overtaxed and cause a seemingly inexplicable breakdown in the future.

The mechanical elements of a crane are very simple, a few gears, track wheels, shafts, the motors, drum, brakes and the necessary framing to support and hold the mechanism, is about all there is to the trolley, but it will not do to put this together in "any old way." The phrase, "in a workmanlike manner," is susceptible of various interpretations, as there is no particular standard, and each one must judge according to his own lights. It is hardly necessary to say that cost counts in cranes as in everything else. The crane builders are not in it for pleasure and the shop facilities as well as the number that can be built from one set of patterns is important, all changes add to their costs and the endeavor is to get up a set of standard sizes that will enable them to suit the general run of customers with most of whom the price decides the question. The maximum amount of trolly travel calls for a short trolley. The minimum of headroom can only be entered by a low trolly. The maximum amount of hoist can only be obtained by a trolley which can be placed close to the roof chords. Ease of repair requires that all parts shall be arranged so that any piece can be removed and replaced with a minimum

amount of trouble and labor. All bearings should be capped, as shafting has a habit of getting bent so that it is impossible to remove it from a solid bearing without cutting it to pieces. With hack saws this is a tedious job, but it can be done very rapidly by burning the shaft in two by an electric arc, provided power enough is available. With capped bearings bent shafts can be removed and straightened, perhaps they ought not to become bent, but it does happen just the same. With cranes it is not easy to make repairs, the space to move around in is limited and the risk of a tumble makes a man cautious, one hand is often only available. This fact is not as thoroughly appreciated as it should be by crane designers.

Crane gears are important items, particularly as they wear out in time. Cast iron gears, if properly proportioned, work well, but it is a good plan to have pinions of steel. In this combination the pinion wears out before the gear. In a great many cases a little more pig iron would improve the gears. Where this is the case cast steel can be used to advantage in making repairs, as owing to the limitations of space, etc., it is rarely possible to make any changes in the main dimension.

Lightness is particularly important in a crane, as it counts in the girders requisite, but a crane that is too light is continually giving trouble, and in the long run it costs more than a heavier machine.

Safety devices of different kinds are occasionally employed to prevent over hoisting, and running the trolley or bridge full tilt into the end stops as commonly designed. Their utility is questionable, for the crane operator can hold the circuit breaker in and at the same time use the controller to get back past the safety line. The best arrangement of such devices is to so place them so that the operator will have to call assistance to hold the circuit breaker in until he can run back to a point where it will stay closed. When the operator finds that he gets caught in this way it is only a matter of time before he discovers a way to get around the circuit breaker. Over hoisting generally brings a pretty good strain on the mechanism. It is very likely to result in broken chain sheaves and a bending of shaft. One accident of this kind is about all a crane operator should have charged up to him, and unless he loses his head the results are not very serious. Running the trolley or bridge into the end stops at full speed is a very efficient

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way of testing the strength of the crane girders and runway, but there is a certain amount of danger in it, so that it is not advisable to do this intentionally. It is an expensive job if anything fails, and more than one crane has refused to stop at the end of the runway. This accident has also been caused by high winds, showing that for a yard crane a good anchor is necessary. The longitudinal and lateral strength of a great many crane runways is much lower than it should be, as only the static loading is considered and the roof trusses are depended upon for sway bracing. As they are not designed for this, the whole building is easily swayed in both directions by the crane.

The track wheels are depended upon, in most cases, for keeping a crane in line, or square, on the runway. These wheels should be of the same circumference. Double flanged wheels of cast steel or cast iron with chilled treads are used, both materials give satisfactory service. Chilled tread wheels should have their flanges made in sand, as otherwise there is considerable liability of the flanges breaking off in case the crane gets badly out of line or the runway varies from gage. With steel wheels the liability of breakage is diminished, but being soft the tread is likely to wear. The flanges are sometimes rolled over and spread apart by a poor runway, this on driving wheels having a gear mounted on their hub forces the gear over so that it cuts into the truck beam. The removal of a steel wheel when this has occurred is a very pleasant piece of work.

It is almost impossible to keep a crane absolutely in line or square, but if proper precautions are taken it is possible to get very fair results. The line shaft should be driven as nearly midway between its ends as practicable, and is preferably a little too large than too small. It may be well to say that what is large to one man may seem small to another. When the line shaft is driven near one end there is a certain amount of torsional spring to it that permits one end of the crane to lag behind, producing a racking action that does not improve the wearing qualities of the machine. This same effect can also be produced by starting the bridge travel suddenly with a heavy load close to one end. It is perfectly practicable to connect the girders and track beams so that this injurious racking tendency can be, to a large extent, overcome, but it is not often done.

Runways that are out of line or not level, or a combination of these two defects, do not have a good effect on a crane and cause excessive wear on the bridge driving mechanism. The correction of runway imperfections is comparatively simple, but unless the structure is very thoroughly braced, it will soon be as bad as before.

There are a number of types of crane girders, two connected at the ends being used for all except very light machines.

The single webbed plate girder was extensively employed at one time. The bottom chord, however, has a tendency to vibrate considerably when the crane is in motion. This is increased by sudden starts and stops. The weight of the line shaft and motor causes torsional strains and the metal is not well distributed to resist them. Rapid starting and stopping increase these strains. This type of girder is not suited for high speed cranes unless sway bracing can be used; in this case the trolley is placed between the girders and runs on the bottom chord. Where the trolley runs on the top chord a system of auxiliary latticing can be used, making in effect two girders at right angles to each other and by this means a high degree of lateral stiffness can be obtained at the sacrifice of simplicity.

The double webbed plate or box girder is the simplest form used in crane work, the metal is well distributed to resist all the strains met in service, the rivets can all be driven by machine, the use of stiffners for the web plates can be avoided by using distance pieces and bolts or long rivets to hold the webs. These girders can be made as stiff as desired laterally and vertically. Occasionally a girder of this kind is made very deep and light web plates used, but this sacrifices almost all the stiffness and is not very good practice. The principal disadvantage of the box girder is that there is no way to inspect or paint the inside.

Lattice girders are used extensively for yard cranes on account of the small amount of exposed surface. They are also employed for long span indoor cranes. The trolley can be placed on either the top or bottom chord to suit the conditions met with.

The failure of crane girders is comparatively rare, as they can generally hold a considerable overload, nevertheless it is not a good plan to use a crane for anything heavier than its rated load, as this has a tendency to develop weak spots that in the future

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may cause trouble. In some cases a five-ton crane has handled nearly twenty tons, but the operator was taking big chances of spoiling the machine and starting several funerals.

The effect of impact on cranes is often neglected. In rapid working these stresses may be equal to those due to the dead load, so that the factor of safety is only one-half of what it would be if these stresses were taken into account in the first place.

Some of the foregoing remarks apply to cranes that are not driven by electric motors, and it is hoped that some information useful to crane users and the prospective purchasers of the machines has been brought out.

In the foundry, as well as some other places, it will be found that the electric overhead traveler furnishes no panacea for difficulties inherent to the handling of heavy work, though it is a valuable accessory. A large part of its calls are for turning moulds, lifting copes, etc., which are too heavy for the moulder. Very often it is necessary to hold such a load for some time, while there may be other floors waiting and losing valuable time. The old foundry jib crane should not be discarded on the advent of the traveler, but rather should be reinforced by a number of light jib or post cranes so that the traveler can be used at its maximum efficiency on lifts proportionate to its capacity.

A great many crane break-downs are due to carelessness or forgetfulness on the part of the crane operator. For instance, he blocks the gearing with a bolt or nut while making some slight repair, then starts the machine and the firm sends out a rush order for new gears. It is a good plan to carry a set of spares for all parts likely to become disabled or worn out in service, this avoids expensive express charges, and the extra cost of rushed work. In ordering such spares it should be specified that each piece shall be properly marked so that it can be easily identified.

Journal of the American Foundrymen's Association.

VOL. IX. PART I.

THE FOUNDRY OF THE GENERAL ELECTRIC COMPANY AT SCHENECTADY, N. Y.

BY MR. C. L. PRINCE.

In a general way, a foundry probably affords about as little material for an interesting paper as any department of a manufacturing concern. The usual lack of machinery and the same general methods pursued in doing work make it difficult, where no special methods are singled out, to find points of interest enough to be dignified by the name of a "Paper." Still in these days of large things, a simple description of one of the large and modern foundries of the country may not be entirely amiss.

In a recent issue of one of the trade papers there appeared an article on one of the Philadelphia foundries, containing the statement that it was one of the largest in the country engaged solely in the furnishing of castings for an individual concern, and giving the ground floor area as about 37,900 sq. ft. The General Electric Company's foundry is a size larger than this, covering over 105,000 sq. ft. in the main building, with a wing for cleaning castings of over 12,000 sq. ft., while a "lean-to" covering nearly 14,000 sq. ft. provides room for the heating apparatus, wash room, closet, carpenter shop, rooms for the temporary storage of patterns, etc.—or a total ground floor space of about 131,000 sq. ft., or approximately three acres—a fairly good-sized territory to be looked after as one shop.

The original main building was only 503 ft.x140 ft., with cleaning wing 103 ft.x120 ft., and lean-to 243 ft.x40 ft. This was erected in 1898, the first iron being poured January 5th, 1899.

It was expected that this would be large enough for all demands for several years, but in a few months the rapidly increasing business of the Company indicated that an increase in room was imperative, and plans were drawn for an addition of 240 ft.

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in length to the building. This was finished during the winter of 1899 and occupied early in 1900, and there are already indications that it will soon be crowded to its fullest capacity.

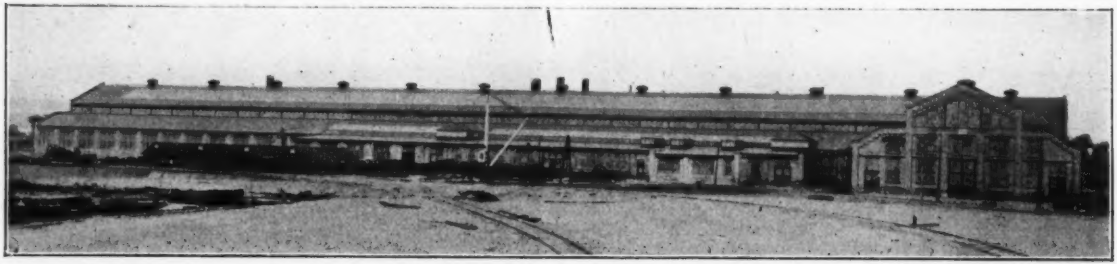
The building is of the most modern construction, having a steel framework for carrying the roof, crane girders, etc., and curtain walls of brick. The steel columns rest on massive concrete piers, calculated for carrying the heaviest loads. In building, 2,322 cu. yds. of concrete were used; 1,761 cu. yds. of stone work; 1,756 tons of steel, and 2,000,000 brick. This surrounds 37,000 cu. yds. of filling, necessary to bring the floor of the foundry up to the standard level of the Works. The height of the side walls is 23 ft. 9in., and that of the gable of the main building is 58 ft. 3 in.

Every provision has been made for having the best possible light in the shop, which presents a strong contrast to the ordinary dark and gloomy foundry. On each side of the roof over the main bay there is a strip of wire glass 22 ft. wide, and running almost the entire length of the building, giving, in connection with the light coming in through the monitor windows, a splendid overhead light, while large windows are placed in the sides and ends wherever possible. Where no side windows are possible, there is wire glass in the corresponding portion of the roof of the side bays. One or two snap shots taken in the foundry during working hours, showing full detail, will be appreciated by those who are photographic fiends. In the windows of the monitor, the ends and sides of the foundry there are over 12,500 panes of ribbed glass used, and 34,856 sq. ft. of wire glass in the roof.

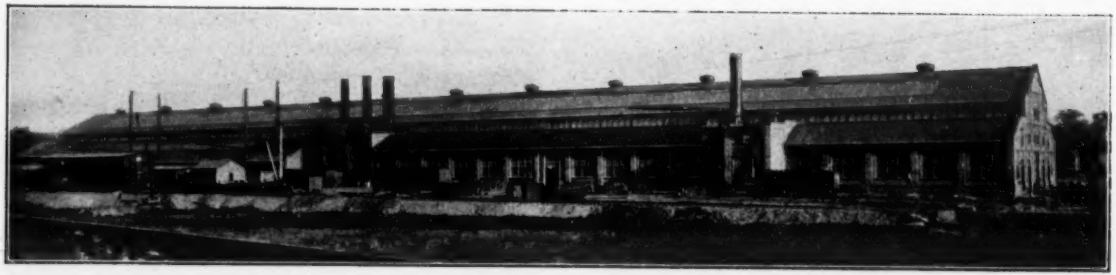
The night lighting is also well looked after. There are between 45 and 50 arc lights in the building for the benefit of the night workers. This is equal to one light for every 2,600 or 2,700 sq. ft., and gives the foundry a brilliant appearance from the outside at night.

Provision is also made at frequent intervals, both on the posts and on the side walls, for attaching leaders for incandescent lights, so that no molder is ever obliged to give the excuse that he "couldn't see well" in explaining the causes of any of his bad work.

Passing to some of the details, it will be noticed that electricity is the only motive power used in the foundry, which is



FOUNDRY—FRONT VIEW.



REAR VIEW OF FOUNDRY.

evidently the proper course to follow at the General Electric Works. A possible exception to this might be taken in the use of compressed air to operate the molding machines, chippers, sand blast, etc., but as the air for operating these is compressed in the foundry by electrically driven compressors, the statement may be considered as substantially correct. Counting in those in the electric cranes, there are over 50 distinct motors in regular use in the building, for all purposes.

One of the most important features in a foundry is the crane outfit, as on this very largely depends the rapid and economical handling of material, and the serving of molders. The main bay of the foundry under consideration is supplied with three traveling cranes of 65 ft. span, and of 40, 15 and 10 tons capacity, the side bays have in all seven travelers of 5 and 7 tons capacity, one of these being over the core room, covering the entire area, for handling large cores. A 10-ton traveler covers the main bay of the cleaning room, with hand travelers on the side bays.

As auxiliaries in doing the work in the main bay there are 9 jib cranes provided, of 20 ft., 25 ft., and 30 ft. jibs, and supported on the posts between the main and side bays. These are of 5-ton capacity, with electric hoists, but hand swing and trolley. The important feature about these is their mobility. On almost every post on both sides are located pintles, fitted to receive these cranes. The latter are so arranged that any one of the travelers can hook into a loop on the top of each of the jibs, and lift the crane off, carrying it to any other place where it may be wanted, and dropping it over another set of pins. The electric switches are snapped in place and the crane is again ready for work. Seven minutes is sufficient to change a crane from one end of the building to the other and have it working. This makes it possible for a few cranes to practically cover the entire space, and enables the molder to have just the length of jib that may be best suited to his work. There are also light cranes with free trolley that are used for supporting the pneumatic rammers, and which may be used at the same places if the work demands it.

The melting capacity is another very important matter in a foundry. This is looked after here by four cupolas—three in the old part of the foundry, and one in the new part. Those in

INTERIOR VIEW OF FOUNDRY.

DRYING MOLD.

the old part have melting capacities of 15, 11 and 7 tons per hour, and that in the new part, 12 tons. Only two of the three in the old part are used at any one time, but with the one in the new part these would take care of any heat that is liable to occur. So far, 110 tons is the largest single heat that has been poured; but this will be increased in the near future considerably.

The pig iron and coke are brought in from the yard on cars and elevated to the charging floor, which is of steel, and intended to carry a heavy load, so that a large amount can be stored here if desired. The blowers are located close by the cupolas, giving very direct connection. They are both of the positive blast type, and are belted from motors.

All of the lighter work is located near the single cupola, so that the iron has to be carried only a short distance for this class of work—in most cases less than 100 ft. This ensures hot iron for all castings. Ladle cars of 2,000 lbs. capacity are also used to carry the iron from the cupola to the near vicinity of the molders needing it, and there filling the hand ladles.

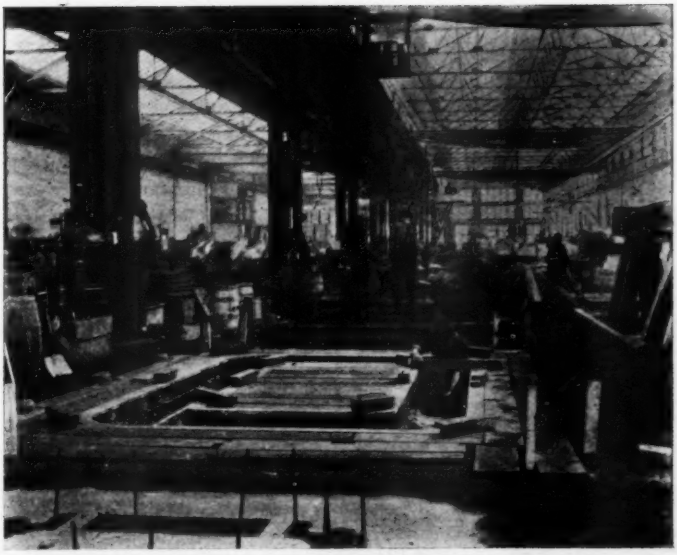
A full supply of ladles is provided, from 15 tons down, so that quite heavy castings could be poured if desired. So far, nothing over 40,000 lbs. has been made.

The main bay is very largely given over to the heavier class of work, while the side bays take care of the medium and light class.

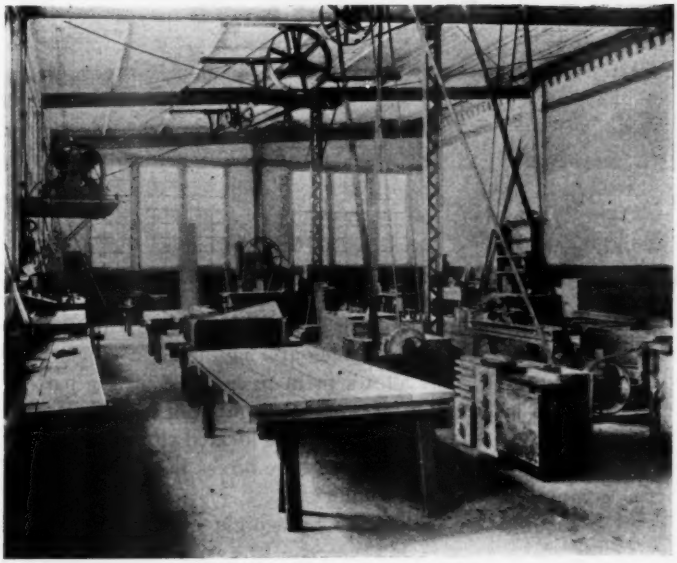
There is only a small proportion of bench work done.

As at first stated, there are no special methods of molding employed that would be of interest. The work is of a practically uniform character in the various branches, and does not call for much change in method from the ordinary lines. The work is practically all green sand, the molds for the heavier pieces being skin-dried. Many of the large copes are dried in two of the ovens that will be referred to later.

Much of the larger work is bedded in, and there is at times a good proportion of sweep work. For drying some of the molds and copes in position a special heating arrangement is used. This consists of a portable electric fan, which is placed near the mold and the blast from this is carried in an annular ring around the fire, and the heated blast is forced down into the mold, the



MOLDING A SWEEP BASE.



FLASK ROOM.

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cope of which is left on, drying it quickly and uniformly. This is more clearly shown in the photograph.

The core room has some features that are worthy of attention. It takes in one side bay for about 300 ft. by 36 ft. wide, the ovens extending 14 ft. beyond this. This gives room for the core-making, mixing of core sand, and facing, and the storage of cores that are waiting to be used. Of the latter there are six in all, two being Millet ovens, two for medium size cores, 36 ft.x11 ft., and two for large cores, 19 ft.x24 ft. deep. Two more of the same size are located just beyond the core room for drying molds, etc., but are so arranged that they can be used for drying cores if desired.

The tracks from all of these large ovens extend into the main bay to enable the travelers to load these cars if necessary. The cars of the medium core ovens present one peculiar feature: Instead of having any loose doors, the scheme was followed of having each car, of which there are four to each oven, carry its own doors. In other words, both ends of each car are made the same size as the opening of the oven, and therefore closes the opening tightly, whether the car is run entirely in or out. The movement of the car is accomplished by means of compressed air. A 6 in. cylinder is fastened to the floor in front of each car, and the piston-rod of this is fastened to the front of the core car, so that as the piston is moved by the air, in either direction, the car has a corresponding movement. In this way one can, by a slight motion of a valve, control perfectly the heaviest loaded cars. It also allows the cars to stay most of the time in the ovens, it taking only a short time to run a car out, put on the green cores and run it back again. A large escape of heat is also prevented. Ample racks are provided for the storage of finished cores that are waiting to be used.

In mixing core sand and facing in this department a double Gould and Eberhardt sifter, and a Sellers centrifugal mixer are used. In both cases the machines are mounted on trucks and driven by motors. This allows them to be used in any part of the room, and when not in use to be drawn out of the way.

A large shed, about 20 ft.x100 ft., is located close by the core room for the temporary storage of core boxes belonging to patterns that are in use in the foundry.

The castings are shaken out by a night gang and taken to

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CUPOLAS IN OLD PART.

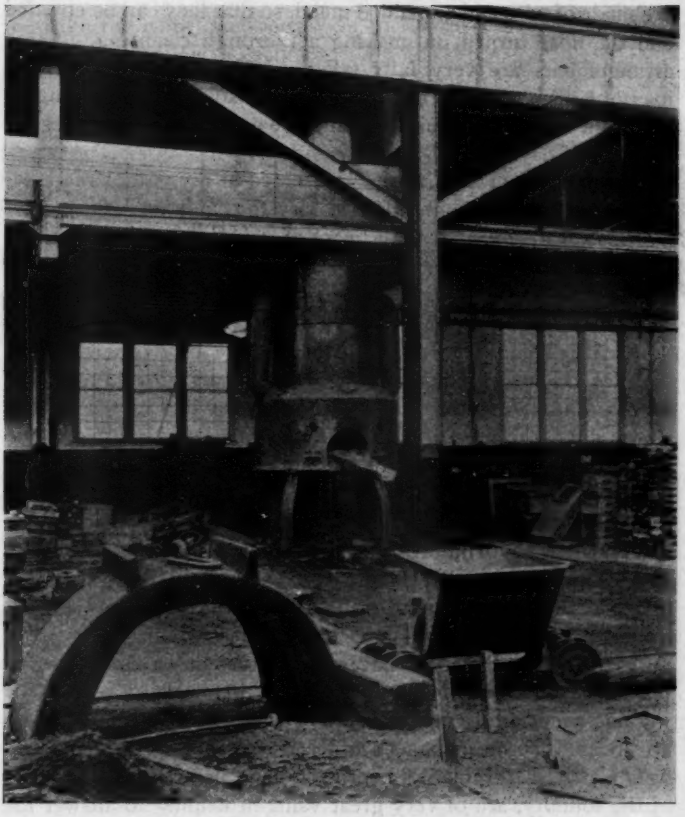
a cleaning room in the wing, where they are cleaned, chipped and weighed. A battery of nine tumbling mills is located at one side of the room. These are all of the exhaust type, so that all dust from them is carried outside of the building. The smaller and medium-sized castings that can not be so treated are cleaned by the sand blast that is located between the foundry and cleaning room, and connected with both by tracks. Pneumatic chisels are freely used in chipping the castings. After cleaning, the castings are weighed, loaded on cars and shipped to the various departments of the Works ordering them.

The sheds for supplies are located on the west side of the building, and afford storage for coal, coke, clay, sharp and molding sands of various grades, flour, etc. These are mainly brought into the foundry by cars on the "industrial" railway—21½ in. gauge—of which there is nearly one mile connected with the foundry. This runs to all parts of the building, and is the principal means of moving sand, cupola bottoms, small castings and the like.

The regular Works track of 3 ft. gauge also enters the building at various points, while the standard gauge runs alongside the sheds.

The lean-to on the east side contains the heating apparatus, wash room, closets, rooms for patterns, store room and flask room. The heating of so large a building is quite a problem. It is met in this case by the indirect method. Air is drawn over large coils of steam pipe by two large fans, 14 ft. diam. and 7 ft. face, and after heating, discharged into the various parts of the foundry. This gives a constant supply of fresh air, and a comfortable shop for work—the temperature last winter, during the coldest weather, in working hours seldom falling below 50°. During the warmer months the steam is shut off, but the fans are kept in motion while pouring off, and during the morning in the very hot weather. This rapidly clears out the smoke and dust through the monitor windows, the upper part of which is arranged for conveniently opening from the floor. This, in connection with 12 large star ventilators in the roof, enables the air to be kept comparatively clear and pure under all circumstances, and the influence on the molders is clearly evident.

Special attention is also paid to the comfort of the men in the matter of cleanliness. A large, well lighted and ventilated



CUPOLA IN NEW PART.

wash room is provided, where the men can wash, either in running water at the trough, or, if they wish, in shower baths, with warm water. Sufficient lockers are provided, so that every man, if he desires, can make a complete change of clothes, and the set not in use can be locked up until needed. The lockers are made of wire and expanded metal, so that they can be emptied and the hose turned on, making a thorough cleansing. These arrangements are very fully taken advantage of by the men, many of them wearing decidedly natty costumes when going to and from their work, while sporting the ordinary molder's regalia during the day.

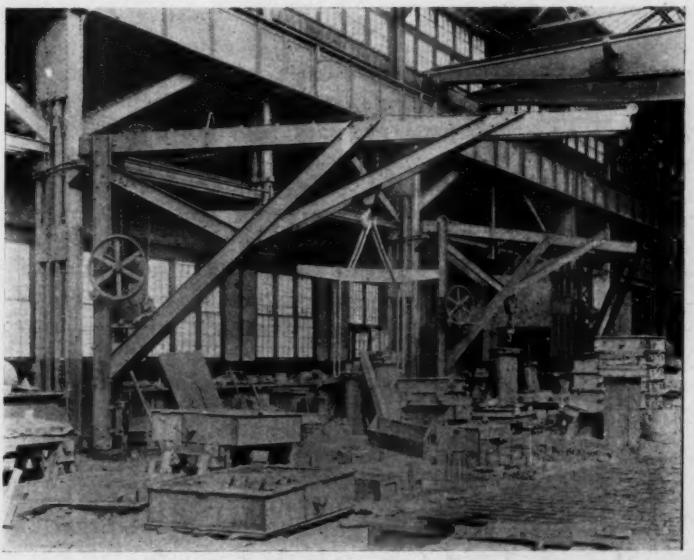
A flask room 40 ft.x80 ft. is situated at the end of the lean-to, and is provided with all necessary tools for making and repairing all the flasks, both wooden and iron, in use in the Foundry. All minor repairs to patterns in active use are made here, while larger repairs and changes are made at the pattern shop, in another part of the Works.

In the central part of the lean-to are two rooms, where patterns are stored temporarily, waiting for a chance to put them in the sand. A pattern clerk is located in one of the rooms, whose duty is to keep a close track of all patterns coming in and going out—their location, the molders having them in charge, and the piece price of molding. At the foundry side of this room, and elevated several feet above the floor is the manager's office, with a bay window—a rather unusual feature in a foundry —projecting out so that almost every part of the room is visible in a general way, although, to be exact, field glasses are almost, if not quite, necessary to see clearly at the extreme end.

These long distances have made necessary a time-saver in the shape of a set of shop telephones, in order to reduce the walking necessary to get information as much as possible. These are located in the manager's office, and with the pattern clerk, weigh- master, foreman of core-room, and near the extreme end of the foundry, are of very great value in helping to answer the numerous questions regarding the condition of castings.

At present there are over 600 men employed in the foundry, of whom 275 are molders and apprentices, 60 are core-makers and apprentices, the balance being chippers, helpers and laborers. In this connection it might be of interest to say that on pay night they are usually all paid off in about fourteen minutes after the whistle.

This, in a general way, will give a fair idea of this foundry. As at first stated, there is but little that is novel in it, outside of a few minor details, but enough has been given to show that the aim of the Company is to provide a shop that is first-class in every detail, that will conduce to the comfort or convenience of the men, to provide them with all appliances that will tend to expedite the work, and then look to them for a rapid and economical production of castings.



MOVABLE JIB CRANE.

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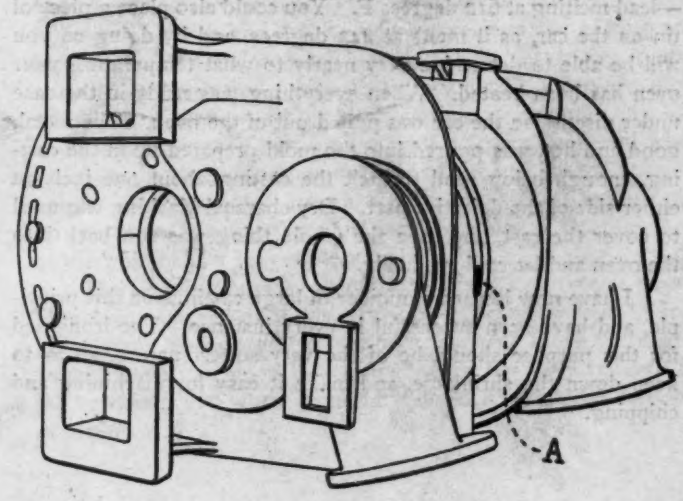
Journal of the American Foundrymen's Association.

VOL. IX. PART I.

THE BURNING OR MENDING OF CASTINGS.

BY MR. EDWARD B. GILMORE, MILWAUKEE, WIS.

It has often been questioned whether it was advisable to burn castings which are broken or have proved defective, even after a great deal of expense had been put upon them, and when one begins to theorize upon the matter, the natural conclusion derived is that it is impossible to mend a casting by burning. When we get to practice, however, we find that the reverse is the case, and I have burned castings which were considered by many founders to be hopeless. For instance, in making a marine cylinder, a piece was broken from a sharp point of the exhaust core which the coremakers had not secured fast enough, and this caused a hole to be left clear through to the outside of the casting, as is shown by A in the accompanying cut.



The procedure that we adopted was based upon the laws which govern expansion and contraction as nearly as possible. We put the casting upon a car with the defective side uppermost, and made loam molds to cover this, also a loam mold to fit the inside of the casting at the same place. Then we took back the molds, dressed them up and gave them a coat of blacking, dried them thoroughly, put them back to their places, and secured them tightly to the casting. We then made a runner to take off the metal poured upon the casting, the overflow of which was caught in another ladle placed for the purpose. After all the arrangements had been completed the whole thing was put into the oven, which is a very important matter, as you must get the casting as well warmed as possible, for this is where the success or failure in burning comes in.

It is essential to have a casting to be treated in this way heated up to at least 600 degrees F., and this can easily be accomplished. After an oven is thoroughly heated with the usual coke fire, about one hour and one-half before you have the metal ready for burning, fill the fire in the oven with soft wood, and continue doing so until ready. This will raise the temperature to the desired point. In order to assure yourself that the oven is hot enough you can put a piece of lead upon the car; if it melts you may be certain that you have the temperature high enough —lead melting at 612 degrees F. You could also place a piece of tin on the car, as it melts at 442 degrees, and by doing so you will be able to determine very nearly to what temperature your oven has been heated. When everything was ready in the case under discussion the car was pulled out of the oven. The metal, good and hot, was poured into the mold prepared upon the casting, enough being used to melt the casting about one inch on either side of the defective part. Dry charcoal blacking was used to cover the cast, and then the whole thing was run back into the oven and let cool gradually.

I have now burned a number of large castings on this principle, and have been successful in every instance. The iron used for this purpose should be of the very softest nature, so as to keep down the shrinkage, and make it easy for machining and chipping.

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There are many castings which can be easily burned without being brought up to this excessive heat, such as when you have to mend on some extreme point, where undue expansion and contraction will not matter. We once had occasion to burn the casing of a centrifugal pump which got broken right across the casting. This was burned very successfully without preliminary heating, but even in this case it would have been advisable to heat the casting, as it would have facilitated the running of the metal. I have seen castings of this description burned cold, and as soon as the metal touched the cold iron it was chilled, and the consequence was a failure. The result was that the pieces were thrown away, and this only on account of an insufficient knowledge of the best methods in the art of burning and mending of castings.

Some founders in burning castings make a practice of bringing the metal forward in small ladles, with the idea of bringing it very hot in this way. This is a mistake, as you can put it all into one ladle and by having a large quantity it will hold its high temperature for a longer period. When you pour you can maintain a good, steady stream upon the part, besides reducing the extra expense of additional help in handling so many ladles.

In burning the neck on rolls, it is much better to adopt the principle of making a loam mold, leaving a hole at the bottom so as to run off the metal until the roll is melted. After the mold is prepared, finish and dry it, then secure it to the casting and build a good hot fire around the casting at the part to be repaired until it is a bright red. Now pour very hot iron into the mold and allow it to flow off until the casting is melted. This can easily be determined by trying it with a feeling rod, and when satisfied stop the exit of the metal and fill the mold to the required height. You can also burn a steel face on to a hammer die on the same principle, but it is not necessary to heat the steel as the iron melts it very rapidly.

The question is very often asked, "Is the casting as strong after being burned as it was previous to being broken?" In a great many instances it is stronger, as very often there is a contraction strain upon the casting which has been relieved by the breaking, and when properly mended it should be certainly as strong.

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VOL. IX. PART I.

SHOT IRON. HOW TO RECOVER IT, AND HOW TO USE IT.

BY MR. C. H. PUTNAM, MOLINE, ILL.

In most foundries there is going forward a constant and heavy waste of iron, day by day, year after year, while, strange as it may seem, the founder is in many cases totally unconscious of the fact; and those who realize that there is a waste, are in entire ignorance of its magnitude. We have been taught that the small particles of iron that escape from the tumbling mill, and are thrown out with the refuse are not, in any true sense, waste; for, it is claimed, this iron is of no real value, as it will not mix, and it has a hardening effect upon the mixture.

I have recently learned that there is a much greater quantity of iron thrown away than I had suspected, and that, though it does harden the mixture to some extent, this is not sufficient to preclude the possibility of its economical consumption. I am aware that some writers on foundry practice aver that there is no economy in using it; that, as noticed above, it hardens the mixture, and that, also, much of it is burnt up, and so destroyed. While it is quite probable that some of the very thin, light particles are indeed consumed in the remelting, it is, nevertheless, certain that the greater part melts and mixes with the other iron. This I know, for I have tested the matter by melting a quantity by itself, weighing it into the cupola, and afterwards weighing the product, the latter being 90 per cent. of the amount charged. The shrinkage in some kinds of pig iron will equal this.

Our method is as follows: We pass the cupola cinders through the tumbling mill (as has always been our custom), continuing the tumbling until the cinders are thoroughly crushed, and everything but the iron has sifted out between the staves,

which, in our practice, fit rather closely, for the purpose of saving as much iron as possible by this process..

Now, the refuse dust and fine cinder, which formerly was dumped out, as being entirely worthless, is passed through the magnetic separator; and the amount daily recovered from the dump of two cupolas is something in excess of 550 pounds of iron, which will yield 500 pounds after sifting, or 450 pounds after remelting. The product, when melted by itself, is a strongly mottled pig. But, as this shot iron is distributed throughout the heat, as mixed in the daily cast, its hardening effect is very slight, and, in a well ordered mixture, cannot be detected in any but very light, thin castings.

But you cannot use this shot iron in all mixtures, any more than that you can use certain pig irons in all mixtures. If you are going to use the shot iron regularly, the pig mixture must be regulated with this fact in view.

When we first began using this shot iron, we had some No. 2 soft charcoal iron which we were using in the regular soft iron mixture, and we had no trouble whatever. Later, the charcoal iron having been all consumed, we made a mixture of all coke iron, employing, of course, the usual quantity of scrap (50 per cent., which includes our shop remelt), with the result that the light castings were altogether too hard for drilling. There were but few of these castings made, and they were thrown into the scrap.

In the process that I now immediately began, and prosecuted to a conclusion, may be seen the method of a branch of the "rule of thumb" foundry practice.

The shot iron was left out entirely, and the balance of the mixture made as before. A few of the light castings only were made, and these were cast at different parts of the heat. Result, too hard for the light castings that had to be drilled, but all right for the balance. There were three different numbers of pig iron in the mixture, viz., No. 2 soft, Southern; No. 2 foundry, Southern, and No. 1 Northern. The two former were from an unfamiliar furnace. So the per cent. of No. 2 foundry was diminished, with good result. Cutting down of the No. 2 foundry was continued until that brand was entirely eliminated, and, even then, the product was not so soft as to enable the use of the shot iron in the light castings. During the process we had

also changed the per cent. of No. 1 iron in the mixture, to correct shrinkage. The loss consequent upon the "rule of thumb" method of correcting our mixture, would amount, in money, to very little.

Now, we omitted the shot iron from the first 7,000 pounds charged in the cupola, which enabled us to cast the light work before the mixture containing the shot iron came down.

As the No. 2 foundry iron was too hard for our use, except in the heavier castings, we bought from a different furnace; and now we are again using the shot iron without difficulty.

We have had no difficulty consequent upon the use of the shot iron, except in the matter of hardness. To overcome this, it is only necessary to use a sufficiently soft pig iron in the mixture. We have not been obliged to use any specially soft iron in the mixture—just ordinary No. 2 soft, No. 2 foundry and No. 1 foundry—the same brands that we were using before we began melting the shot iron.

The actual saving in our case is, say, 450 pounds of iron per day, @ 67c $3.00 per day.

The time consumed in operating the separator must be considered, of course; but this is so trivial that no additional labor is employed, the work of running the separator having been added to the duties of the laborers who work about the cupola.

The magnetic separator that we use is one that Messrs. Barnard & Leas, of Moline, Ill., invented and perfected during the past year, and which they are now manufacturing for the trade. I do not wish to make any invidious comparisons between this machine and other machines manufactured for the like purpose; however, a general description of it may not be out of place. ..

The machine is, essentially, in shape a cylinder, wound with copper wire which, in operation, is charged with electricity. This cylinder is set in the frame at an incline that will cause the cinders to pass through, from the one end where they are charged, out at the other, the magnetized inner surface of the cylinder catching and holding fast every particle of iron. It might seem, at first thought, that some of the iron particles would get brushed out with the dust and coke cinders; but it should be borne in mind that the iron in contact with the

cylinder is itself magnetized, and therefore holds firmly any iron that comes in contact with it. When the current is thrown off the iron "lets go" from the cylinder and pours out into the receptacle. The work of operating this machine is as simple and easy as running a power sand sifter. Cost of current for the machine is less than two cents per hour, and one hour's labor will run the day's product through.

The machine weighs about 1,100 lbs., and occupies a floor space of 2.5x10 feet.

In conclusion, I wish to state that the saving effected by us is less, by a good deal, than what it would be in foundries where extraordinary care is not taken to extract the iron from the cinders, by having close-fitting staves in the cinder-mill. In fact, it is quite obvious that, in view of the difference in the care taken in various foundries in this respect, the saving by the use of the separator in some foundries would be two or three times what it is with us.

One very important point to bear in mind is that, no matter how large or how small the pieces of iron, none can escape the vigilance of the machine. So that, if the operator of your cinder-mill becomes careless, permitting wide spaces between the staves, which will pass large pieces of iron, that would ordinarily go to the dump, the magnetic separator will catch this iron and save it for you.

It is our intention to provide wider spaces between the mill staves, so as to obviate the necessity for so much grinding in order to reduce the cinder. This will save somewhat of time and wear of machinery, without any loss of thoroughness in the extraction of the iron.

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